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Reevaluation of the Impact of Coal Mining on the Virginia State Budget

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Executive Summary

Downstream Strategies, an environmental consulting and policy analysis firm, published *The Impact of Coal on the Virginia State Budget* in 2012, finding that the coal mining industry was responsible for a net cost of $21.9 million to the Commonwealth in 2009 (considering only the Virginia General Assembly's General Fund and Transportation Fund revenues and expenditures). We provide a reanalysis of the same topic, considering the effect the presence of the coal industry has on the entire state budget that is not limited to the General Fund. We estimate that in our study year of 2011, the coal industry contributed $31.95 million in taxes and fees to the state while the Commonwealth's expenditures relating to the coal industry totaled $24.4 million. However, firms producing coal in Virginia also benefit from two exclusive refundable tax credits which we estimate combine to $49.37 million. We find that the coal industry was associated with a net cost of $36.7 million to the Virginia state budget in 2011.

Overview

Despite annual coal production falling by two-thirds since 1990, the coal industry represents a significant portion of the regional economy in the seven southwestern counties of Virginia, accounting for almost 19 percent of the total labor income in the region. Statewide, however, its impact is smaller, producing less than one percent of the total value of private industry goods and services in 2011.

The primary manner in which state expenditures concern the coal industry is through the Virginia Department of Mines, Minerals, and Energy (VDMME) and the Virginia Department of Transportation (VDOT). VDMME accounts for nearly 75 percent ($17.9 million) of the state's coal-related expenditures, mostly through regulating contemporary mining and through reclaiming abandoned mining lands (AML's). VDOT is responsible for another 25 percent ($6.1 million) of state expenditures through its Revenue Sharing Program, which provides coal-producing counties funding used to rebuild coal hauling roads.

Our estimation of VDOT's spending to rebuild coal hauling roads represents an indirect method of quantifying the actual impact that coal hauling operations have on Virginia roadways. The actual cost of pavement damage caused by coal trucks may be larger or smaller than VDOT's expenditures, so we provide an in-depth methodology to provide an estimate of the actual pavement damage caused by coal hauling trucks and calculate the corresponding cost of pavement replacement. We estimate that in 2011 coal hauling activities were responsible for approximately $10.3 million in pavement damage. Yet, we also note that these roadway expenditures could be reduced if the Commonwealth built their roads using thicker pavements that would incur less damage from heavy coal trucks.

We estimate that the majority of the coal industry's contributions to the Virginia state budget in 2011 come from the corporate income tax ($4.6 million) and the state retail sales tax ($10.4 million). Various fees and fuel taxes account for another $3.6 million. The largest single contribution, $13.4 million, is paid for through federal coal severance taxes and is disbursed by the US Office of Surface Mining Reclamation and Enforcement (US OSMRE) for the reclamation of AML's.

Although the scope of this project was to estimate only the state budget impacts of the coal industry, we also provide appendices to briefly discuss the local severance taxes that coal producers pay, the defrayed cost of AML reclamation provided to the state through coal mining companies' use of 'remining' methods, and the decreased cost of construction of the proposed

Coalfields Expressway using ‘coal synergy’ construction practices. These appendices provide a glimpse of the larger picture of the Virginia coal industry and its interactions with state and local governments.

1. Introduction

In 2012, Downstream Strategies, an environmental consulting and policy analysis firm, published *The Impact of Coal on the Virginia State Budget.* They analyzed how the presence of the coal industry in Virginia contributed to tax revenues and caused governmental expenditures, finding that in FY2009 the coal industry was responsible for a net cost of $21.9 million to the Commonwealth. Our research is a reinvestigation of this topic. We replicate the analysis used by Downstream Strategies (DS) in some areas and change it in others when we believe there are superior methodologies. We also find several ways to extend the inquiry and advance the body of knowledge regarding this issue. We find that in our study year of 2011, the presence of the coal industry in Virginia led to a net cost of $36.7 million to the state government. To be clear, we do not take a position whether this is an appropriate figure or not. We leave the discussion of the proper size of the net contributions of various industries to other forms of debate within the Commonwealth.

Overview

At the outset we state, much the same as Downstream Strategies did, that we do not claim our estimates of the state government revenues and expenditures related to the coal industry are perfect or that we have considered every manner in which the state government receives funds from or spends money in relation to the coal industry. As would be the case for any related study, much of our analysis faced limitations on data availability. In many cases we do not have knowledge of the specific exchanges between the state government and coal industry firms, but wherever possible, we contacted the state agencies that work directly with firms in the coal industry in order to obtain the best information available. We generally fared better at this in relation to the Commonwealth's expenditures rather than revenues. Only one agency's expenditures – the Virginia Department of Taxation (VDT) – required indirect estimation. In contrast, the majority of the state revenues received from the coal industry required indirect estimation, since the VDT does not keep records of industry-specific tax revenues.

Methodology

Our analysis uses 2011 as the study year of interest. This is because 2011 represented the most recent data available for the IMPLAN (Impact analysis for PLANing) economic impact software that we use to model the impact of the coal industry on the state and regional economies. We implicitly assume that our use of 2011 as a study year is sufficiently similar to the study year of 2009 as used by Downstream Strategies to permit comparison between our results. However, some of the data –coal production quantities, for example – varied somewhat significantly by year. Because of this whenever possible we use the average annual estimate of revenues or expenditures based upon a five-year period centered on 2011. This allows our analysis to incorporate some of the same data as used by Downstream Strategies while at the same time helping safeguard that unusual perturbations in the data do not adversely influence our final estimate. In some cases we are unable to use a five year period and so make the next best study period selection, based upon data availability and context.

Another reason for using estimates of average annual government revenue and expenditures over multi-year time periods is due to the fact that the data we use comes from a mixed batch of sources, some of which report annual data values in terms of calendar years (CY) and some of which report the data in terms of fiscal years (FY), which run from July to June in Virginia. Where possible, we specify which specific time period we refer to. However, rather than try to account for two-year averages of calendar years in order to associate them with the fiscal year which straddles them, we make the assumption that changes in state revenues and expenditures do not occur so swiftly as to make the six-month difference between calendar years and fiscal years to be problematic. Much of the data that we collect supports this assumption and our use of multi-year averaging helps mitigate the issue in the instances when the data does show considerable year-to-year variability.

Another way that our methodology differs from that of Downstream Strategies is that we consider all revenues and expenditures from the state government related to the coal industry. DS limited their consideration to monies accruing to and spent from either the General Fund or the Transportation Fund of the Virginia General Assembly. Their stated purpose in doing so was to estimate the coal industry's impact on the discretionary spending portion of the state budget. We do not limit our methodology in this way, and attempt to paint a fuller picture of the impact of the coal industry on the entire state budget, rather than a portion of it. This, at least in part, helps account for why the estimates of specific revenues and expenditures we find are often larger than those found by Downstream Strategies. To facilitate comparison between the two reports, we provide a summary of the methodology and results of the Downstream Strategies report in Appendix 1A.

Analytical Perspective

One area in which our investigation differs substantially from that of Downstream Strategies is in our analytical perspective. We apply the 'benefits-received principle' to provide a consistent structure to evaluate the interactions between the Commonwealth and coal industry. The benefits-received principle states that an individual's tax liability is equal to the benefits he or she receives from the government. This means that on net, there should be a zero-value exchange between individuals, firms, and organizations and the government. As applied to this report, it means that a firm in the coal industry and the coal industry overall is not considered to be responsible for any government expenditures except those which occur due to its presence in the state or which directly benefit it. We provide a more substantial discussion of our analytical perspective in Appendix 1B.

Report Structure and General Findings

We first provide an overview of the Virginia coal industry; its past, present, and potential future. Although coal production has fallen by two-thirds since peaking in 1990, the coal industry is still responsible for a substantial portion of the economy in the seven southwestern counties of Virginia. We use IMPLAN to evaluate the impact that the coal industry has on the state and southwestern regional economies. Although coal mining accounted for less than one percent of the total value of goods and services produced by private industry in Virginia in 2011, it was responsible for almost 19 percent of the total labor income in the southwestern coal region.

We next examine Virginia's governmental expenditures related to the coal industry. Nearly 75% of these expenditures come from the Virginia Department of Mines, Minerals, and Energy (VDMME). Funds provided by the Virginia Department of Transportation (VDOT) to counties in the coal region to repair coal hauling roads make up most of the rest of balance. In total we estimate that Virginia spent $24.4 million in coal-related expenditures in 2011.

Following this we present our investigation of the revenues received by Virginia from the coal industry. The analyses we use are more indirect than those used in estimation of the expenditures, but where we utilize similar methodologies to those employed by Downstream Strategies, we obtain similar results. State corporate income and retail sales taxes account for nearly half of the state revenues attributable to the coal industry. We also account for coal mine permit fees, coal hauling truck registration fees and fuel taxes. Lastly, Virginia's Abandoned Mine Lands Program (VAMLP) receives federal funding from the United States Office of Surface Mines through federal coal severance taxes created by the Surface Mining Control and Reclamation Act of 1977. This funding represents a substantial subsidy provided by current coal producers (and consumers) to the state to mitigate the problems associated with coal mining activities prior to 1981. However, these revenues, totaling $31.95 million, are offset by two exclusive state tax credits provided to the coal industry. The Coalfield Employment and Enhancement Tax Credit (CEETC) and the Virginia Coal Employment and Production Incentive Tax Credit (VCEPITC) combined are estimated to be $49.37 million and obviate the aggregate state taxes paid by coal firms. Because these are refundable credits, the end result is that the *net* impact of coal industry tax revenues on the Virginia state budget is estimated to be a loss of $12.3 million.[1]

Lastly, we extend the body of knowledge regarding the cost of roadway damage attributable to heavy trucks by providing a combination engineering-economic analysis of coal hauling operations on Virginia roadways. We account for road reconstruction expenditures in Section 3 of this report, but provide this analysis as a more scientific and structured method to estimate the actual cost of coal hauling roadway impacts. Using data provided by VDOT on truck traffic in the southwestern region, we estimate the reduction in pavement lifetime associated with the damage caused by coal hauling trucks. That information, combined with

[1]The remaining $5.09 million is sent to the Virginia Coalfield Economic Development Authority, per Virginia tax law.

assumptions regarding the initial roadway construction, allows for an estimation of the dollar value of the pavement damage. In total, we find that the cost of pavement deterioration of coal hauling activities was around $10.3 million in CY2011. This estimate is near VDOT's average annual expenditures associated with reconstruction of coal hauling roads from FY2010 through FY2014.

Although the scope of this project was solely concerned the coal industry's impact on the Virginia state budget, we include several appendices to illustrate the larger context in which the coal industry contributes to and receives benefits from governments in Virginia. The largest current example of this is in the local severance taxes the coal industry pays, but the planned Coalfields Expressway – a new highway to be built using 'coal synergy' construction methods – also is estimated to provide substantial benefits to the state. In addition, through the practice of 'remining,' the coal industry is responsible for reclaiming a significant amount of abandoned mining lands which otherwise might not be restored to their previous condition due to a lack of funding. Our final analysis does not consider these items, however, since they do not impact the state budget in our study year of 2011.

2. The Virginia Coal Industry

Overview of Virginia's Coal Industry

The Virginia coal industry is a smaller part of the overall state economy than it is in West Virginia or Kentucky. The total quantity of coal reserves and economically recoverable coal resources is much higher in these states than in Virginia (US EIA, 2015b). Virginia's coal region is limited to seven southwestern counties, with Buchanan, Wise and Dickenson Counties representing the primary counties where the vast majority of the coal is mined. Although it is not a large constituent of the statewide economy, coal mining has been a significant part of the local economy in these coal counties since the 1880s when railroads linking the coal region to the greater US economy were built (Grymes, 2014). Employment in the coal industry in 2011 accounted for 7% of total employment in the coal counties but only 0.12% of total employment across the state (IMPLAN, 2011). In fact, over 98% of all coal industry jobs are located in the coal counties (IMPLAN, 2011).

Virginia's coal production has been trending steadily downward for over two decades after peaking at 46.5 million short tons in 1990 (see Figure 1-1) (VCCER, 2014b). To place this in a national context, Virginia accounted for 4.5% of the 1.03 billion tons of coal produced in the US in 1990 (US EIA, 2015d). Virginia's production has since fallen to 16.6 million short tons in 2013 – less than 2% of total US production (US EIA, 2015a). Over the same time period, the number of active coal mines in Virginia declined from 338 to 82 (US EIA, 2015d).

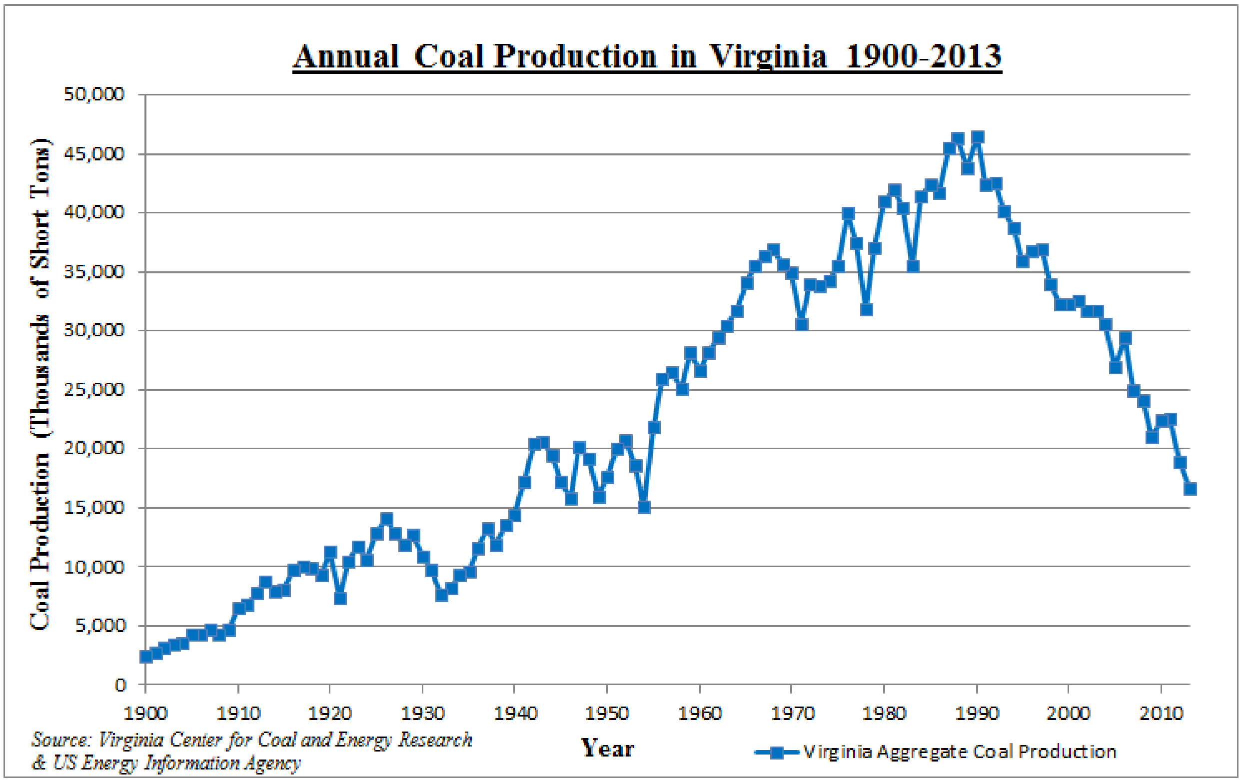

Figure 2-1: Virginia Annual Coal Production

Two major reasons for the decline in Virginia's coal production can be found in the relatively high cost of extraction compared to other coal-producing regions across the US and to declining available reserves within Virginia (VCCER, 2014a). Most of Virginia's coal mines are located in rugged Appalachian terrain. The difficulty of accessing the coal increases the cost of mining while simultaneously decreasing the portion of in-place coal that can be recovered. In addition, many of the coal seams in Virginia are relatively thin, further increasing the unit cost of the recovered coal (VCCER, 2014a). As a result, Virginia's coal mines are near the bottom of the national rankings in terms of coal production per employee-hour (US EIA, 2015c). Furthermore, much of Virginia's original coal resource has already been mined. As of 2013 only 261 million tons of recoverable reserves remained at operating mines, which corresponds to just 1.3% of the

US total recoverable reserves (US EIA, 2015b). Other unmined coal resources do exist, but they generally face as high or higher mining costs than the already-mined resources.

The disadvantages facing coal mining in Virginia are partially offset by the high quality of the coal. Around half of the coal mined in Virginia is used in industrial or metallurgical applications (VDMME, 2014b). Metallurgical coal has high heat content and low amounts of impurities which allow it to be used to create coke, a fuel used in producing steel. Conversely, 'steam coal' has lower heat content and higher levels of impurities and is generally used to produce electricity. Virginia's coal of all types is sold at substantially higher than average prices due its higher quality and closer access to coal markets in the eastern and southern US (see Table 1-1) (VDMME, 2014b). In addition, the higher grades of coal can exported to satisfy demand in international markets. Hampton Roads, the primary export location for Virginia's coal, shipped 50 million tons of coal to international markets in 2012 (Virginia Maritime Association, 2014). Table 1-2 shows the quantity of exported coal for Virginia, West Virginia, and Kentucky.

Average Annual Sale Price per Short Ton of Coal

Coal-Producing State	Year	
	2011	2012
Virginia	$135.14	$109.40
West Virginia (Northern Counties)	$61.27	$63.34
West Virginia (Southern Counties)	$95.44	$91.40
Kentucky (Eastern Counties)	$74.70	$75.62
Kentucky (Western Counties)	$45.89	$48.67
National Average	$41.01	$39.95

Source: US Energy Information Administration, Annual Coal Report 2012, Table 28.

Table 2-1: Average Coal Sale Prices for Selected Regions

Distribution of US-Produced Coal to Domestic and Foreign Buyers (Millions of Short Tons)

Coal-Producing State	Year			
	2011		2012	
	Domestic	Exports	Domestic	Exports
Virginia	14.33	10.85	11.01	8.89
West Virginia (Northern Counties)	36.46	5.65	31.45	6.97
West Virginia (Southern Counties)	59.65	33.92	40.52	40.51
Kentucky (Eastern Counties)	56.39	6.09	35.2	6.05
Kentucky (Western Counties)	39.76	1.9	39.28	2.79
National Average	981.46	107.26	877.32	125.75

Source: US Energy Information Administration, Annual Coal Distribution Report 2012.

Table 2-2: Distribution of Coal Production from Selected Regions

Impacts of the Virginia Coal Industry on the State Economy

The IMpact analysis for PLANing (IMPLAN) software, produced by IMPLAN Group, LLC, was used to estimate the effect of the coal industry on the Virginia economy. IMPLAN uses an input-output economic model with data provided by the US Bureau of Economic Analysis (BEA), the US Bureau of Labor Statistics (BLS), and the US Census, among other sources, to estimate the interconnections between industries in a given region during a specific time period (IMPLAN, 2014a). The IMPLAN software is one of several input-output models commonly used to estimate the economic effect of governmental programs and changes in the economy. Detailed information on IMPLAN, input-output economic modeling, and the assumptions/limitations of this method of analysis is provided in Appendix 2.

The IMPLAN analysis conducted for this report uses a reference year of 2011, which represented the most recent information available at the commencement of the project. The estimates provided by the analysis are reflective of the specific economic conditions, inter-industry connections and levels of industry output in Virginia in 2011. Any application of these results to other years or to forecast future results must be made with the explicit assumption that the specific circumstances and relationships that existed in 2011 are also applicable in the time period considered. Yet, despite these caveats, the underlying input-output relationships do not change much on a year-to-year basis.

Three regions were analyzed with IMPLAN. The first covers the entire state of Virginia, including all counties and cities, and is referred to as the 'statewide analysis.' This analysis will show the largest impacts of the coal industry since the region is the least restricted. The 'southwestern region analysis' includes only the seven southwestern coal counties in order to focus on the region in which the vast majority of coal mining activities take place. The 'primary coal county analysis' focuses on the sub-region of coal counties most likely to benefit from the coal industry. Conducting the analysis with subsequent smaller sub-regions allows for an estimation of the degree to which the industry impacts are localized in the coal counties. See Tables 1-3 and 1-4 for a detailed summary of the IMPLAN analysis results.

IMPLAN Statewide Analysis

The Virginia coal industry constitutes a relatively small part of the overall state economy, especially compared to other coal-producing states. Part of this is due to low levels of coal production (in 2011 less than two percent of all coal mined in the US was produced in Virginia) and part is due to the larger total value produced by Virginia's economy. The 2011 Virginia private industry Gross State Product (GSP) was estimated to be $340.7 billion, which is almost two-and-a-half times larger than Kentucky and over six times larger than West Virginia (US BEA, 2014).[2]

IMPLAN estimates that the coal industry's total production value, which includes all coal mines and coal preparation plants, was $2.3 billion in 2011. This corresponds to about 0.67% of the total private industry GSP that year. 5,673 jobs[3] were associated with the coal industry, although this number does not include independent proprietors.[4] The coal industry's share of total state employment is only 0.12%, but it paid 0.22% of total labor income,[5] which amounted to $657.76 million. The average compensation[6] to wage and salary workers equaled nearly $82,000, meaning that the average coal industry job provides substantially higher wages than the 'average job'[7] in the state, for which the annual compensation was around $57,800.

The output multiplier calculated by IMPLAN for Virginia in 2011 was 1.62. This indicates that an additional million dollars of output value produced by the coal industry was associated with another $620,000 worth of increased production by other industries serving the coal industry and in industries providing good and services to those employed in the affected industries. IMPLAN estimated the total value of intermediate inputs[8] to coal production to be $963.85 million, of which 59% ($570.89 million) went to purchases from in-state industries.

[2]GSP is expressed in chained 2009 dollars.
[3]IMPLAN measures employment as the annual average of the monthly number of full-time and part-time jobs. This number does not include the number of proprietors (IMPLAN, 2014d).
[4]IMPLAN defines proprietors as self-employed individuals and unincorporated business owners (IMPLAN, 2014d).
[5]IMPLAN defines labor income as the sum of employee compensation and proprietor income (IMPLAN, 2014d).
[6]IMPLAN defines employee compensation as the total payroll cost of the employee paid by the employer, including wages/salary, all benefits, and all payroll taxes (IMPLAN, 2014d).
[7]The annual compensation for the 'average job' in Virginia in 2011 was calculated by dividing IMPLAN's total Employee Compensation by the Total Employment.
[8]IMPLAN defines intermediate inputs as the goods and services which are used in the production of other goods and services (IMPLAN, 2014d).

The employment multiplier calculated by IMPLAN for the Virginia coal industry in 2011 was 2.60. This means that each job in the coal industry was associated with an additional 1.60 jobs in the statewide economy. IMPLAN also uses an alternate, more intuitive method, to explain this effect. If the demand for coal rose by one million dollars in output value, IMPLAN estimates that this change would require 2.45 additional coal industry jobs and would be associated with 1.71 additional jobs in industries supplying the coal industry with production inputs. The increase in aggregate household income from these jobs would then induce an additional 2.21 jobs in industries providing goods and services that meet households' demand.

IMPLAN Southwestern Region Analysis

Although the coal industry represents a small proportion of Virginia's overall economy, it plays a crucial role in the economy of the southwestern coal region (Buchanan, Wise, Dickenson, Lee, Russell, Tazewell, and Scott Counties). It is the seven-county region's second-largest employer (5,595 jobs), after state and local public education institutions. It provides the highest total labor income (over $640 million), which is nearly the same as the sum of the labor income of the next three highest ranked industry classifications (state and local public education institutions; state and local non-education institutions; federal government, non-military). This corresponds to 7% of the region's total employment and 18.7% of the total labor income. IMPLAN estimates the average compensation of a coal industry job to be $81,900 while the corresponding annual compensation for the 'average job' in the region was less than $38,300.

The southwestern region multipliers found by IMPLAN are smaller than those found in the statewide analysis, as expected. The output multiplier estimate was 1.38 – each additional million dollars of coal output leads to an additional $380,000 worth of production of coal industry inputs or household consumables in the southwestern region. The employment multiplier was estimated to be 1.97, meaning that each additional coal industry job was associated with an extra 0.97 jobs in the region. Another way of expressing the same results is that an additional million dollars of coal production in 2011 would correspond to 2.46 additional coal industry jobs, 1.20 jobs in industries supplying the coal industry, and 1.18 jobs providing goods and services to households in the southwestern region.

IMPLAN Primary Coal County Analysis

The southwestern region analysis indicates how important the coal industry is to the local economy, and illustrates the intensity of concentration of the coal industry in the region compared to the rest of the state – less than 2% of all coal industry jobs were located outside of the seven county southwestern region. The need for an additional sub-region analysis becomes clear when differences between the primary and secondary coal counties are considered. Buchanan, Wise, and Dickenson Counties are identified as the 'primary coal counties' because they have provided over 80% of the coal mined in Virginia since the 1880's (VCCER, 2014b). The size of this dichotomy can be seen in Figure 1-2, which shows the annual coal production per county.

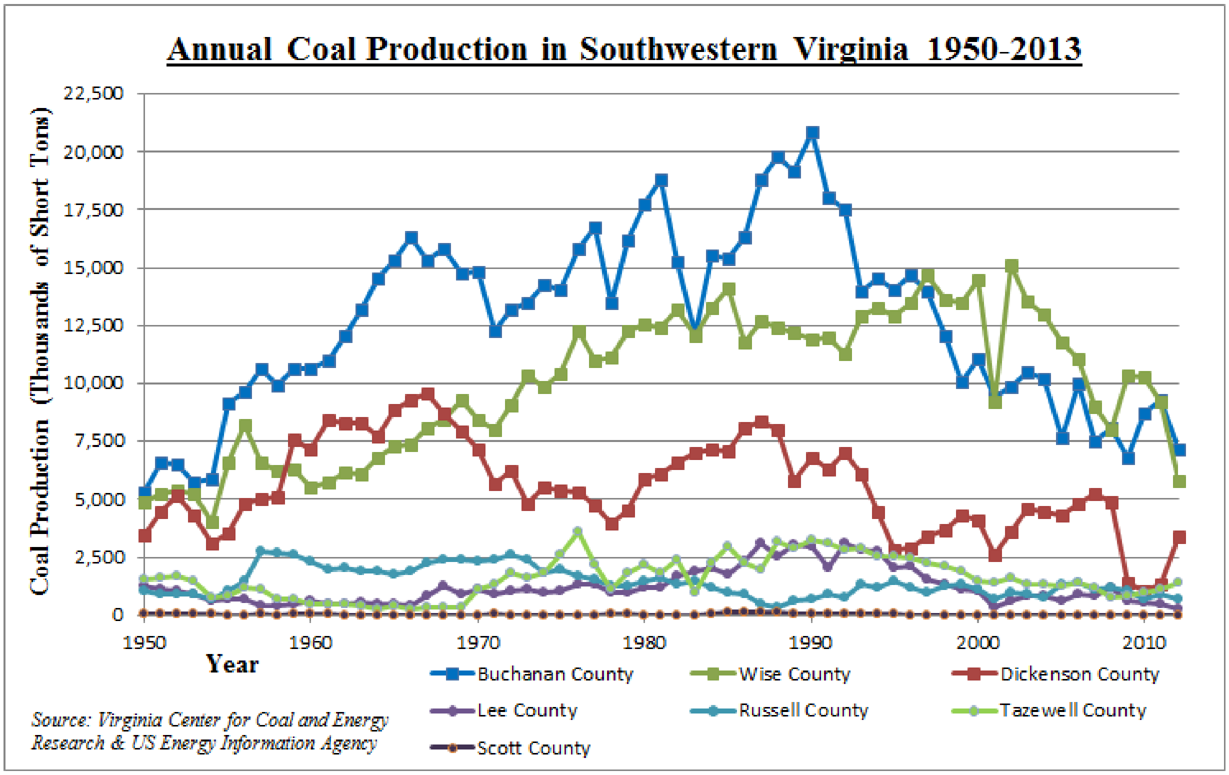

Figure 2-2: Virginia Annual Coal Production by County

The IMPLAN results show that 84% of all coal industry jobs (4,783) are located in these three counties. It is the sub-region's largest employer and also provides the highest aggregate labor income ($549.84 million). One out of every seven jobs in these three counties is employed by the coal industry (14.4% of total employment) and it provides almost a third of the total labor income for the three-county sub-region.

The primary coal county multipliers estimated by IMPLAN are smaller than for the southwestern region, indicating that there is a degree of 'leakage' of economic activity from the primary coal counties to the larger region, just as there is leakage from the southwestern counties to the rest of the state. The output multiplier was estimated to be 1.29 – for a million dollar increase in coal production there is a corresponding increase of $290,000 in production value in other industries in the three-county area. The employment multiplier of 1.74 indicates that each coal job was associated with another 0.74 jobs in the primary coal counties. Another way of expressing these results is that a million dollar increase in coal production was correlated with 2.46 additional jobs in the coal industry, 0.88 jobs in industries supporting coal production, and 0.94 jobs providing goods and services to households in the three-county sub-region.

The Future of Virginia's Coal Industry

The production of coal in Virginia will likely continue to decline for multiple reasons. The dramatic increase in supply of natural gas (and corresponding fall in price) due to recent drilling innovations targeting shale gas resources has accelerated the trend of switching from coal- to natural gas-fired power plants. As of the year 2000, 51.7% of electricity in the US was generated by coal-fired power plants and 15.8% was generated using natural gas (US EIA, 2012a). By 2013 coal's share had declined to 39.1% while natural gas-fueled power plants rose to provide 27.4% of the electricity supply (US EIA, 2014b). This trend is projected to continue, with natural gas supplanting coal as the primary fuel for electricity generation around 2035 (see Figure 3) (US EIA, 2014a). Furthermore, nearly 20% of coal-fired electricity generating capacity is projected to be retired by 2020, with the majority occurring before the EPA's Mercury and Air Toxics Standard (MATS) emission regulation takes full effect in 2016 (US EIA, 2014c; US EPA, 2013a). In addition, the lower-cost coal resources from Wyoming's Powder River Basin have been making inroads into the Eastern and Southern US markets previously served by the coal resources of the Central Appalachian Basin (see Figure 4) (US EIA, 2012b). These changes by themselves would diminish the demand for high-cost coal from Virginia, but the price of coal-powered electricity is likely to climb higher due to the cost of compliance with the EPA's proposed Carbon Pollution Standard (US EPA, 2013b). As the demand for coal used in electricity generation falters, Virginia's production of steam coal is likely to see further declines.

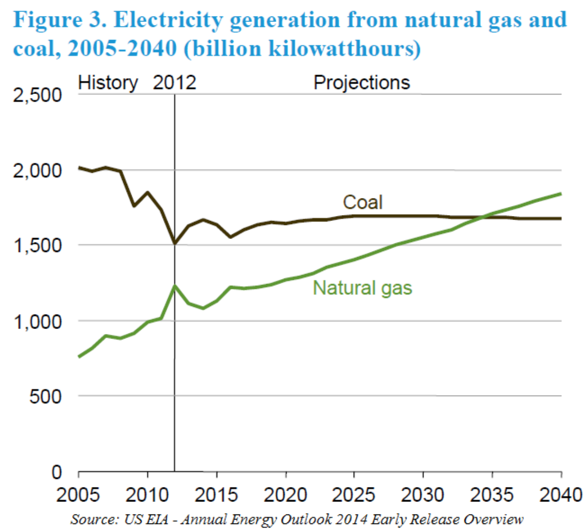

Figure 2-3: Projected Trends for Coal and Natural Gas Electricity Generation

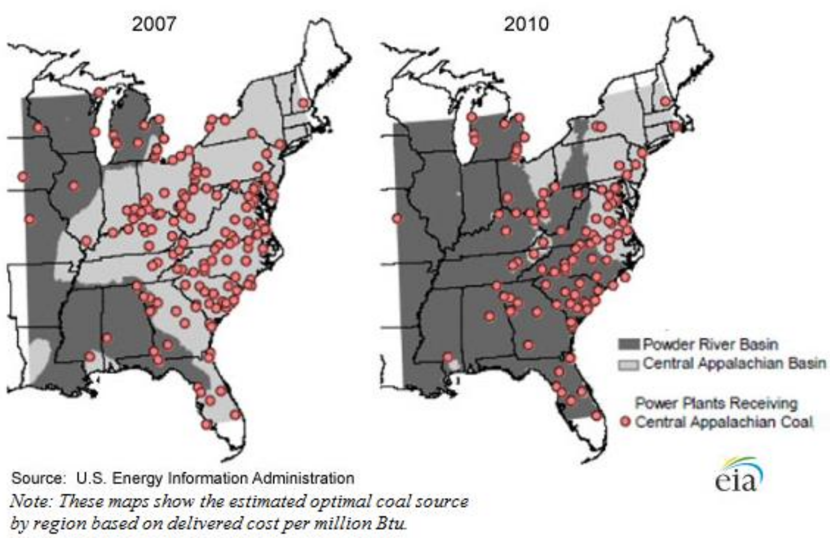

Figure 2-4: Optimal Source of Coal by Delivered Cost

To compound the decline in overall coal demand, the quantity of economically-recoverable coal resources in Virginia is also limited. This has played a large part in the drop in coal production over the last two decades. If coal production continues to fall at the same rate, declining by nearly 1.1 million short tons every year, the Virginia coal industry will cease production by 2030.

We surmise that a total collapse of Virginia's coal industry is unlikely because of the quality of Virginia's coal resources. International demand for high-quality coal has been rising due to economic expansion in developing countries, such as China and India. Virginia's metallurgical and high-quality industrial coal, combined with the Virginia coal counties' relatively low cost to access international markets through the port at Hampton Roads, might forestall a complete breakdown of coal production. The market for industrial coal can be highly variable though. As the domestic demand for Virginia's steam coal declines and the proportion of local production supplying metallurgical coal correspondingly increases, the coal counties in Virginia will be exposed to more significant boom-bust impacts from international price shocks. It will become increasingly important over the next decade for the residents of Virginia's coal counties to find new opportunities for economic development, especially those which are resilient to boom-bust effects.[9]

[9]For a discussion of boom-bust economic impacts from the energy industry and policy recommendations on how to mitigate the negative aspects of the bust, refer to "Making Shale Development Work for Ohio", a publication of the C. William Swank Rural-Urban Policy Program at Ohio State University.

IMPLAN Analysis of the Economic Impact of the Coal Industry by Region						
Analysis Region	**Analysis Type**	**Direct Effects[5]**	**Indirect Effects[6]**	**Induced Effects[7]**	**Total Effects[8]**	**Social Accounting Matrix Multiplier[9]**
Virginia (All counties)	Output[1]	1.0	0.347472	0.272133	1.619605	1.619605
	Employment[2]	2.45216	1.710638	2.205535	6.368333	2.59703
	Total Labor Income[3]	0.284314	0.113808	0.091317	0.489439	1.721473
	Employee Compensation[4]	0.200884	0.102938	0.081307	0.385128	1.917172
Coal Region (Buchanan, Wise, Dickenson, Lee, Russell, Tazewell, and Scott Counties)	Output[1]	1.0	0.237186	0.140119	1.377305	1.377305
	Employment[2]	2.459581	1.195366	1.183	4.837947	1.96698
	Total Labor Income[3]	0.282148	0.060486	0.035301	0.377936	1.339493
	Employee Compensation[4]	0.201501	0.055005	0.032066	0.288573	1.432116
Primary Coal Counties (Buchanan, Wise and Dickenson Counties)	Output[1]	1.0	0.178381	0.106756	1.285137	1.285137
	Employment[2]	2.45806	0.878107	0.941742	4.277908	1.74036
	Total Labor Income[3]	0.282592	0.052299	0.027636	0.362527	1.282864
	Employee Compensation[4]	0.201647	0.048233	0.026154	0.276034	1.368898

Note: See Appendix 2 for a discussion of the IMPLAN methodology.

Footnotes:

1 - Multiplying each Output-related "Effect" by $1,000,000 provides the estimated increase in production value correlated with a $1,000,000 increase in the value of coal production.

2 - The Employment-related "Effects" are measured in relation to an increase in the value of coal production of $1.0 million. For example, an increase in $1,000,000 in coal production in the Virginia analysis is correlated with 2.45 additional coal industry jobs, 1.71 additional jobs in industries supporting the coal industry, and 2.21 jobs in industries satisfying household demands for goods and services.

3 - Multiplying each Total Labor Income-related "Effect" by $1,000,000 provides the estimated impact on the total labor income (defined as the sum of employee compensation and proprietor income) correlated with a $1,000,000 increase in the value of coal production.

4 - Multiplying each Employee Compensation-related "Effect" by $1,000,000 provides the estimated impact on the total employee compensation (defined as the total payroll cost of the employee paid by the employer, including wages/salary, all benefits and all payroll taxes) correlated with a $1,000,000 increase in the value of coal production.

5 - "Direct Effects" represent the change in the industry under primary consideration – the increase or decrease in the monetary value of production, employment, etc.

6 - "Indirect Effects" represent the change in the industries which support the industry under primary consideration – as well as the changes in tertiary industries that support the secondary industries (and so on). The value listed is the total increase in the monetary value of production, employment, etc., for all indirect effects.

7 - The "Induced Effect" is defined as the change in economic activity due to the change in household consumption stimulated by changes in the wages/salaries paid to workers in the primary, secondary, tertiary, etc., industries.

8 - The "Total Effect" is simply the sum of the Direct, Indirect, and Induced Effects.

9 - The "Social Accounting Matrix Multiplier" is simply the ratio of the Total Effect to the Direct Effect. It measures the relative size of impact that a change in the primary industry has on the rest of the regional economy.

Source: IMPLAN Economic Impact Analysis Software (Data Year: 2011; Industry Code: 21 - Mining coal)

Table 2-3: Economic Impact of the Virginia Coal Industry

Top Ten Employment Multipliers related to the Coal Industry by Industry and Region						
Analysis Region	**IMPLAN Industry Code**	**Industry Name**	**Direct Effects[1]**	**Indirect Effects[2]**	**Induced Effects[3]**	**Total Effect[4]**
Virginia (All counties)	21	Mining coal	1.0	0.014	0.000	1.0139
	413	Food services and drinking places	0.0	0.013	0.104	0.1169
	369	Architectural, engineering, and related services	0.0	0.070	0.003	0.0730
	356	Securities, commodity contracts, investments, and related activities	0.0	0.055	0.017	0.0727
	30	Support activities for other mining	0.0	0.066	0.000	0.0660
	360	Real estate establishments	0.0	0.016	0.048	0.0632
	381	Management of companies and enterprises	0.0	0.046	0.004	0.0496
	335	Transport by truck	0.0	0.041	0.007	0.0478
	394	Offices of physicians, dentists, and other health practitioners	0.0	0.000	0.047	0.0469
	319	Wholesale trade businesses	0.0	0.021	0.025	0.0464
Coal Region (Buchanan, Wise, Dickenson, Lee, Russell, Tazewell, and Scott Counties)	21	Mining coal	1.0	0.030	0.000	1.0300
	30	Support activities for other mining	0.0	0.069	0.000	0.0692
	413	Food services and drinking places	0.0	0.005	0.053	0.0578
	335	Transport by truck	0.0	0.050	0.007	0.0569
	369	Architectural, engineering, and related services	0.0	0.049	0.001	0.0498
	324	Retail Stores - Food and beverage	0.0	0.003	0.031	0.0341
	381	Management of companies and enterprises	0.0	0.032	0.001	0.0329
	425	Civic, social, professional, and similar organizations	0.0	0.011	0.018	0.0289
	354	Monetary authorities and depository credit intermediation activities	0.0	0.018	0.011	0.0287
	329	Retail Stores - General merchandise	0.0	0.003	0.025	0.0278

Note: See Appendix 2 for a discussion of the IMPLAN methodology.

Footnotes:

1 - "Direct Effects" represent the change in the industry under primary consideration – in this case the increase of one job in the coal industry is shown as 1.0 new jobs in the coal industry and 0.0 jobs in other industries.

2 - "Indirect Effects" represent the change in the industries which support the industry under primary consideration – as well as the changes in tertiary industries that support the secondary industries (and so on). The value listed is the total increase in employment for all indirect effects correlated with the increase of one job in the coal industry.

3 - The "Induced Effect" is defined as the change in economic activity due to the change in household consumption stimulated by changes in the wages/salaries paid to workers in the primary, secondary, tertiary, etc., industries. The value listed is the total induced increase in employment correlated with the increase of one job in the coal industry.

4 - The "Total Effect" is simply the sum of the Direct, Indirect, and Induced Effects.

Source: IMPLAN Economic Impact Analysis Software (Data Year: 2011; Industry Code: 21 - Mining coal)

Table 2-4: Coal Industry Employment Multipliers

3. Virginia's Coal-Related Expenditures

Introduction

The primary manner in which the coal industry affects the Virginia state budget is through state agencies purposed with monitoring and regulating coal mining activities. These agencies aim to ensure that economic 'externalities'[10] due to coal production do not improperly affect other residents of the commonwealth and that coal production occurs in a manner that is safe for the miners and the surrounding community. In an economic system with more clearly defined property rights and a more efficient legal system for handling personal damage suits (e.g., wherein a stream's owner could bring suit against a coal producer for allowing acid runoff to pollute the stream), there would be less need for state agencies such as these. Given the limitations of contemporary economic and legal systems, these agencies represent a 'second-best' solution to ensure that coal production activities do not infringe upon the property rights and safety of others. The following state agencies were identified as being directly involved with coal industry monitoring and regulation activities:

- Virginia Department of Mines, Minerals, and Energy (VDMME)
- Virginia Coal Energy Commission (VCEC)
- Virginia Department of Motor Vehicles (VDMV)
- Virginia Department of Forestry (VDF)

[10]The term 'externality' in economics is used to indicate a cost of production that is not borne by the producer and therefore is not incorporated into the producer's decision-making process and whose effect is not included in the final price the consumer pays for the product. For example, coal production can produce acidic runoff into streams and rivers, which then negatively impacts the quality of the waterways and subsequently their value for fishing, boating, and other recreation, as well as lowering the value of the land adjacent to the waterway downstream from the contamination.

In addition to monitoring and regulation of actual industry activities, it is also necessary to estimate Virginia's expenditures in other state agencies that are responsible for mitigating the secondary effects of coal production. Examples of these indirect, on-budget costs include environmental cleanup activities, costs associated with the coal industry's use of public roads, and the cost incurred to collect taxes to cover regulation expenses. Expenditures by these agencies are considered:

- Virginia Department of Transportation (VDOT)
- Virginia Department of Environmental Quality (VDEQ)
- Virginia Department of Taxation (VDT)

Lastly, the state government's provision of some public services, such as law enforcement and the court system, is a benefit received by the coal industry, similar to the provision of public roads. However, unlike the cost to rehabilitate a road or collect taxes, it is too difficult to quantify the amount of public law enforcement and legal services consumed by any given industry. The value of the service consumed is also likely to be highly variable from year to year, depending on how often firms in the coal industry had appeared in court or filed police reports regarding stolen property, etc. Furthermore, any estimate of the amount of law enforcement or legal system expenditures attributable to corporations is complicated by the fact that individuals also benefit from these same services. An appropriate estimation of these expenses attributable to individuals or industries requires codification of legal concepts not currently part of American law. Therefore, this type of governmental expenditure is noted as a relevant expense associated with coal industry operations, but is not included due to the difficulty of accurate estimation.

Virginia Department of Mines, Minerals, and Energy

The Virginia Department of Mines, Minerals and Energy (VDMME) is the government agency which incurs the most significant costs in monitoring and regulating the coal industry. VDMME includes the Division of Mines (DM) and Division of Mined Land Reclamation (DMLR), both of which are solely concerned with coal mining activities. In addition, the Division of Administration (DA) coordinates and supports DM and DMLR operations, which constitute a large part of the total activities of the VDMME. The other divisions of the VDMME are focused on different industries (mineral mining, natural gas and oil extraction, etc.) and therefore do not face costs associated with the coal industry.

VDMME provided data on budgeted expenditures for FY2009 through FY2013 for each of its seven divisions and their estimated amount of those expenses related to the coal industry (See Table 3-1). Based on their figures, VDMME annually spends around $24.5 million on coal industry-related operations (VDMME, 2014c). This number shows very little variation over the five year period, even though the budgeted expenses in non-coal related VDMME divisions have fluctuated from year to year. Over the same time period the amount of coal produced in Virginia decreased from 24.2 million tons mined in CY2008 to 16.6 million tons in CY2013 (US EIA, 2014d; US EIA, 2015a). The fact that VDMME's coal-related expenses remained constant during a multi-year period when coal production fell by 31 percent may indicate that VDMME's expenditures are not strongly sensitive to coal production volumes, at least in the short run.

VDMME – Division of Mines

The Division of Mines (DM) is responsible for ensuring safety at coal mining operations. It carries out mine safety inspections, investigates mining accidents, and provides training and certification for miners and technical assistance to mine operators (VDMME, 2012b). One hundred percent of the DM's expenses are used in coal industry-related regulation or support (VDMME, 2014c). The average annual appropriation for the DM from FY2009 through FY2013 was over $4.6 million, making it the second-largest department by funding in the VDMME (VDMME, 2014c).

VDMME – Division of Mined Land Reclamation

The Division of Mined Land Reclamation (DMLR) regulates coal mining and ensures that mining land is properly reclaimed after mining. It issues permits, conducts inspections, assists mine operators and responds to citizens' concerns in the pursuit of promoting an environmentally sound mining industry that will not permanently mar the landscape or inhibit future uses of the land following coal mining (VDMME, 2012c). One hundred percent of the DMLR's expenses are connected with the coal industry and the average annual appropriation from FY2009 through FY2013 was over $17.6 million, which means the DMLR was responsible for over 50 percent of all VDMME spending in this time period (VDMME, 2014c).

However, a significant portion of DMLR's expenditures are dedicated to Virginia's Abandoned Mine Land (AML) program. These funds are used to reclaim mining sites that pose a hazard to public health, safety, and property, but were mined before the 1977 Surface Mining Control and Reclamation Act (SMCRA) took effect. Coal mines since the SMCRA are required to post bonds to ensure funds are available to reclaim their mining lands if they do not restore the area (US OSMRE, 2012b). This means that according to the 'benefits-received principle' we use to attribute governmental expenditures and revenues, AML expenditures are not attributable to contemporary coal mining operations.[11] DMLR's annual AML expenditures from 2009 through 2013 averaged $6.6 million (Kesterson, 2014). We subtract this from the rest of DMLR's expenditures and use the resulting value, $11.0 million, as the estimate of DMLR expenditures attributable to the contemporary coal industry. We further note that such legacy costs relate to inadequate regulation of older operations and that the reclamation bond program virtually eliminates this concern for current operations.

VDMME – Division of Administration

The Division of Administration (DA) is responsible for the coordination and direction of the other VDMME divisions in accordance with state guidelines and implements the VDMME Strategic Plan and Operational Plan (VDMME, 2012a). A large part of the DA's expenses (almost 70%) are considered to be coal industry-focused, which is unsurprising given that the DM and DMLR have the largest budgets in the VDMME (VDMME, 2014c). From FY2009 through FY2013 the DA spent almost $2.3 million per year on operations associated with the coal industry (VDMME, 2014c).

Virginia Department of Environmental Quality

Virginia's Department of Environmental Quality (VDEQ) is tasked with protecting and improving the environment in order to ensure the continued vitality of the Commonwealth's natural resources for the well-being of all Virginians (VDEQ, 2010). The VDEQ develops Total Maximum Daily Load (TMDL) standards for pollutant levels in the commonwealth's waterways. VDEQ uses TDML Studies to identify specific waterway pollutants and their sources in order to develop plans to reduce pollutant levels (VDEQ, 2014b). Although VDEQ directs a relatively

[11] If regulations requiring the posting of such bonds had been in place originally, the problem and cost of reclaiming abandoned mining lands would not exist. As it now stands, the existence of AML's represents a subsidy from current Virginia residents to coal producers and their customers in previous generations.

large amount of expenditures toward development and enforcement of TMDL's in Virginia's coal region, most of this work is delegated to the VDMME and therefore the costs of these projects are incorporated with VDMME's expenditures (McCurtcher and Mueller, 2014). VDEQ did identify seven projects conducted from FY1995 through FY2014 which were specifically funded through the VDEQ (VDEQ, 2014a). The average annual project cost from FY2010-FY2014 was around $56,000 (VDEQ, 2014a).[12]

Virginia Coal Energy Commission

The Virginia Coal Energy Commission (VCEC) is a part of the Division of Legislative Services (DLS) which serves to "assist legislators in fulfilling their duties and obligations as members of the General Assembly" (DLS, 2014a). The VCEC specifically studies coal and alternative (non-petroleum) energy resources in order to provide legislators with information relevant to issues of industry regulation and support (DLS, 2014b). The annual budget for the VCEC from FY2009 through FY2013 was around $22,000 (VCEC, 2014). However, the average expenditure per year was only $6,000 (VCEC, 2014). The VCEC did not comment on how much of this amount was typically spent on activities relating to the coal industry (Farber, 2014). We assume that the full annual expenditure is related to coal industry information gathering efforts, although this assumption will have a negligible effect on the final results due to the small size of this expenditure relative to other state government expenditures.

Virginia Department of Forestry

The Virginia Department of Forestry (VDF) is responsible for protecting forest resources from fire, managing state forests, and providing technical assistance to private landowners to

[12]The average annual cost for all seven projects from FY1996 through FY2014 was approximately $36,000.

manage forest land (VDF, 2014). VDF maintains forest tree nurseries to provide seedlings used in reforestation, including reclamation of mining land, which is the primary way that it interacts with the coal industry (Cumbia, 2014). The VDF nurseries support their own operations through sales revenue of tree seedlings and therefore the VDF does not expend any state funds in its interaction with the coal industry (Cumbia, 2014).

Virginia Department of Transportation

The Virginia Department of Transportation (VDOT) is responsible for building and maintaining the public transportation network in the Commonwealth (VDOT, 2014e). It also provides funding to local jurisdictions for roadway construction and rehabilitation efforts through the Revenue Sharing Program (RSP) (VDOT, 2014c). Virginia's coal counties use coal severance taxes as a source of local funding required by the RSP to match commonwealth funding (Hill, 2014; Sumpter, 2014). From FY2010 through FY2014 the seven county coal region allocated approximately $8.3 million in coal severance taxes each year to road reconstruction projects focused on repairing secondary roads used by coal hauling trucks (Hill, 2014; Sumpter, 2014). Over the same time period, VDOT provided an annual average of $6.1 million through the RSP to these counties (VDOT, 2009; VDOT, 2010; VDOT, 2011a; VDOT, 2012a; VDOT, 2013a). Since it could be argued that these projects are largely motivated by the significant pavement damage caused by coal transport trucks, the commonwealth's matching funds through the Revenue Sharing Program represent a cost to Virginia created by the coal industry. It is assumed that all matching RSP funds in coal-producing counties are directed towards coal haul roads, as the counties in the coal region which do not spend coal severance taxes on road reconstruction projects (Lee and Scott) receive negligible RSP funding (VDOT, 2009; VDOT, 2010; VDOT, 2011a; VDOT, 2012a; VDOT, 2013a). See Appendix 7 for a brief discussion on the local severance taxes paid by Virginia coal producers.

Virginia Department of Motor Vehicles

The Virginia Department of Motor Vehicles (VDMV) is responsible for vehicle registration, enforcement of transportation-related tax laws, and collection of transportation-related revenues, among other duties (VDMV, 2014a). With regard to the coal industry, VDMV registers and regulates coal transport trucks, whose weight restrictions are governed by VDMV Publication 109. Virginia permits coal and other mineral transport trucks to exceed the typical weight restrictions placed on commercial transport trucks, allowing a gross vehicle weight of 110,000 pounds for a six-axle truck versus 80,000 pounds for a standard five-axle commercial tractor-trailer (VDMV, 2013). Most mineral transport trucks must pay $70 per year for their overweight/oversize hauling permit, but coal transport trucks are exempted from this cost (VDMV, 2013). The additional pavement damage caused by heavier coal hauling trucks is analyzed in Chapter 5 of this report. VDMV spends an average of $169,000 annually for regulation/compliance activities regarding the coal industry transport operations (Davis, 2014).

Virginia Department of Taxation

The Virginia Department of Taxation's (VDT) responsibility is to administer the Commonwealth's tax laws (VDT, 2014a). The VDT's budget reflects a measure of the costs of providing the means for Virginia's companies and citizens to pay taxes and ensuring the tax collection is accurate. The cost of tax collection must be covered by the tax revenue itself, similar to the way that the cost of a credit card transaction must be covered by the purchase price. The VDT, however, does not maintain records of the costs of tax collection or revenues received by industry classification (Josephs, 2014). In order to estimate the coal industry's share of tax collection costs, we first use a method similar to that proposed by Downstream Strategies (2012). This involves assigning a proportion of the VDT's annual budget to the coal industry based upon the proportion of the Gross State Product (GSP) attributable to private industry that is produced by the coal industry. VDT is estimated to have spent an annual average of $148,000 on tax collection efforts associated with the coal industry from FY2009 through FY2012. See Appendix 3 for a discussion of our methodology.

An alternate method for determining the cost of collecting taxes from the coal industry would be to apply the VDT's average cost of tax collection - $0.60 per $100 of collections in FY2011 (VDT, 2011a) - to the total amount of taxes paid by the coal industry. According to the IMPLAN analysis, the production and import taxes paid by the coal industry totaled $190.2 million in CY2011.[13] However, this number represents state, local, and federal taxes, not simply taxes paid to the Commonwealth. Applying the VDT's average cost of collection to this aggregate tax payment produces an estimate of the total cost of collecting taxes from the coal industry of $1.14 million. However, this method may suffer from questionable accuracy[14, 15] and should be considered only as an estimate of an upper-limit of the cost of tax collections from the coal industry incurred by all taxing authorities.

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[13]IMPLAN uses the US BEA's definition of production and import taxes, also referred to as 'indirect business taxes' (IBT) (US BEA, 2006). "IBT can currently be considered the combination of excise, sales and property taxes, as well as, fees, fines, licenses and permits" (IMPLAN, 2014d). This category does not include employer contributions to social insurance and taxes on individual or corporate income.

[14]Based on the IMPLAN analysis, indirect business taxes accounted for almost 98% of the total taxes collected by state and local authorities from the coal industry, while the federal government only collected 10% of the total IBT paid by the coal industry. These proportions are derived from an IMPLAN tax impact analysis considering a $1 million dollar increase in coal production value and so are dependent on the effect of the marginal increase in coal production being consistently related to the total production value of coal in 2011 ($2.313 billion).

[15]Additionally, VDT's average cost of tax collection has shown substantial variation in recent years. The cost per $100 of collections rose from $0.56 in FY2008 to $0.62 in FY2010 and then declined to $0.52 in FY2013 (VDT, 2008; VDT, 2010a; VDT, 2013a). Since production and import tax data from IMPLAN is only available for CY2011, the applicability of this estimate to other years is less accurate.

Conclusion

We estimate that Virginia spent approximately $24.4 million on state government operations that related to the coal industry in FY2011. The Virginia Department of Mines, Minerals, and Energy, tasked with regulating mining safety and restoring mining lands, accounted for nearly 75% of these expenditures. The Virginia Department of Transportation accounted for another 25% of these expenditures through its Revenue Sharing Program, which coal producing counties use to subsidize roadway improvements along coal hauling routes. The remaining $379,000 in expenditures was mostly attributed to the Virginia Department of Motor Vehicles to fund their coal hauling truck registration program and the Virginia Department of Taxation for the collection of state taxes.

When comparing our results to those of Downstream Strategies (see Table 3-2), we find that our estimates for VDMME and VDOT expenditures are substantially larger than those reported by DS. Our methodology for estimating expenditures by VDMME was similar to that used by DS, but we accounted for all appropriations, not just appropriations from the General Fund as DS did. In contrast, our methodology for estimating VDOT's expenses was fundamentally different than that used by DS. We accounted for actual expenditures that were targeted towards coal hauling routes rather than estimating the proportion of overall county roadway funding attributable to coal hauling traffic. Similarly, we used specific project funding information provided by VDEQ and VDMV to estimate those agencies' expenditures relating to the coal industry. Our final estimate of coal industry-related state expenditures was more than double the $11.7 million reported by Downstream Strategies.

Virginia Department of Mines, Minerals and Energy	FY2009 Appropriation	Percent of budget devoted to coal industry related operations	FY2009 funding related to the coal industry	FY2010 Appropriation	Percent of budget devoted to coal industry related operations	FY2010 funding related to the coal industry	FY2011 Appropriation	Percent of budget devoted to coal industry related operations	FY2011 funding related to the coal industry
Division of Geologic & Mineral Resources	$ 1,611,034	0.00%	$ -	$ 982,416	0.00%	$ -	$ 964,530	0.00%	$ -
Division of Mineral Mining	$ 2,719,244	0.00%	$ -	$ 2,701,244	0.00%	$ -	$ 2,568,842	0.00%	$ -
Division of Gas & Oil	$ 1,121,108	0.00%	$ -	$ 1,203,908	0.00%	$ -	$ 1,215,502	0.00%	$ -
Division of Mined Land Reclamation	$ 17,516,834	100.00%	$ 17,516,834	$ 17,803,996	100.00%	$ 17,803,996	$ 17,629,315	100.00%	$ 17,629,315
Division of Mines	$ 4,632,139	100.00%	$ 4,632,139	$ 4,589,739	100.00%	$ 4,589,739	$ 4,665,389	100.00%	$ 4,665,389
Division of Energy	$ 2,122,094	0.00%	$ -	$ 2,466,366	0.00%	$ -	$ 3,337,906	0.00%	$ -
Division of Administration	$ 3,225,328	69.36%	$ 2,237,088	$ 3,111,686	66.43%	$ 2,067,093	$ 3,280,950	69.02%	$ 2,264,512
Total	$ 32,947,781	74.01%	$ 24,386,061	$ 32,859,355	74.44%	$ 24,460,828	$ 33,662,434	72.96%	$ 24,559,216

Virginia Department of Mines, Minerals and Energy	FY2012 Appropriation	Percent of budget devoted to coal industry related operations	FY2012 funding related to the coal industry	FY2013 Appropriation	Percent of budget devoted to coal industry related operations	FY2013 funding related to the coal industry	Average Appropriation FY2009-FY2013	5-year equivalent percentage of budget devoted to coal industry-related operations	Average funding FY2009-FY2013 related to the coal industry
Division of Geologic & Mineral Resources	$ 974,801	0.00%	$ -	$ 1,044,591	0.00%	$ -	$ 1,115,474	0.00%	$ -
Division of Mineral Mining	$ 2,554,389	0.00%	$ -	$ 2,554,389	0.00%	$ -	$ 2,619,622	0.00%	$ -
Division of Gas & Oil	$ 1,201,049	0.00%	$ -	$ 1,578,884	0.00%	$ -	$ 1,264,090	0.00%	$ -
Division of Mined Land Reclamation	$ 17,593,186	100.00%	$ 17,593,186	$ 17,561,186	100.00%	$ 17,561,186	$ 17,620,903	100.00%	$ 17,620,903
Division of Mines	$ 4,650,936	100.00%	$ 4,650,936	$ 4,650,936	100.00%	$ 4,650,936	$ 4,637,828	100.00%	$ 4,637,828
Division of Energy	$ 2,452,011	0.00%	$ -	$ 2,912,973	0.00%	$ -	$ 2,658,270	0.00%	$ -
Division of Administration	$ 3,218,950	69.33%	$ 2,231,698	$ 3,804,803	69.22%	$ 2,633,685	$ 3,328,343	68.71%	$ 2,286,815
Total	$ 32,645,322	74.97%	$ 24,475,820	$ 34,107,762	72.85%	$ 24,845,807	$ 33,244,531	73.83%	$ 24,545,546

Source: Virginia Department of Mines, Minerals, and Energy

Figure 3-1: Annual VDMME Expenditures Related to the Coal Industry

Virginia's Annual Expenditures Related to the Coal Industry		
Virginia State Government Department	**Downstream Strategies FY2009 Estimates[1]**	**Farren/Partridge FY2011 Estimates[2]**
Virginia Dept.of Mines, Minerals and Energy: Division of Mines[3]	$4,116,963	$4,637,828
Virginia Dept.of Mines, Minerals and Energy: Division of Mined Land Reclamation[3]	$2,145,406	$17,620,903
Virginia Dept.of Mines, Minerals and Energy: DMLR - Abandoned Mine Land program[5, 6]	$0	-$6,633,634
Virginia Dept.of Mines, Minerals and Energy: Division of Gas and Oil[3]	$40,000	$0
Virginia Dept.of Mines, Minerals and Energy: Division of Geology and Mineral Resources[3]	$60,000	$0
Virginia Dept.of Mines, Minerals and Energy: Division of Mineral Mining[3]	$0	$0
Virginia Dept.of Mines, Minerals and Energy: Division of Energy[3]	$0	$0
Virginia Dept.of Mines, Minerals and Energy: Administration[3]	$990,000	$2,286,815
Virginia Dept. of Environmental Quality[4]	$2,010,000	$56,000
Virginia Dept. of Taxation[3]	$280,000	$148,000
Virginia Dept. of Motor Vehicles[5]	$0	$169,000
Virginia Dept. of Transportation[4]	$1,500,000	$6,100,000
Virginia Dept. of Forestry[3]	$0	$0
Virginia Coal Energy Commission[3]	$10,000	$6,000
Total	$11,152,369	$24,390,912

Footnotes:

1 - Downstream Strategies only considered expenditures from the Virginia General Assembly's General Fund or Transportation Fund.

2 - Farren/Partridge accounted for all expenditures from the Virginia state budget.

3 - Downstream Strategies and Farren/Partridge used similar methodologies to estimate expenditures.

4 - Downstream Strategies and Farren/Partridge used different methodologies to estimate expenditures.

5 - Downstream Strategies did not account for this expenditure.

6 - Abandoned Mine Land program expenditures are not attributed to the contemporary coal industry.

Source: Virginia Dept. of Mines, Minerals, and Energy, Virginia Dept. of Environmental Quality, Virginia Dept. of Taxation, Virginia Dept. of Motor Vehicles, Virginia Dept. of Transportation, Virginia Dept. of Forestry, Virginia Coal Energy Commission, and Downstream Strategies (2012).

Figure 3-2: Comparison of Virginia's Estimated Expenditures Related to the Coal Industry

4. Coal Industry Contributions to Virginia's Budget

Introduction

Coal mining contributes to the Virginia budget through a variety of taxes and fees. The corporate income tax, retail sales tax, and assorted coal mining permit fees are the most direct sources of revenue for the Commonwealth from the coal industry. More indirect revenue streams include the registration fees and fuel taxes paid by coal hauling trucks. Counties levy a severance tax on coal production, but the funds collected are distributed to the local governments rather than being used by the Commonwealth. However, the 1977 Surface Mining Control and Reclamation Act (SMCRA) created a federal severance tax to reclaim abandoned coal mines. The US Office of Surface Mining Reclamation and Enforcement (US OSMRE) provides annual distributions to Virginia's Abandoned Mining Land program from this severance tax.

It should also be noted that the coal industry provides a significant funding stream to county governments and regional economic development authorities through local taxes and severance taxes. Since the focus of this research is the coal industry's impact on the commonwealth's budget, an analysis of these local tax and fee revenues lies outside of the scope of this report. However, a brief examination of the coal industry's impact on the budget of local governments is provided in Appendix 7 to provide some additional context.

Corporate Income Tax

Virginia assesses a corporate income tax rate of 6 percent on the taxable income of firms incorporated under Virginia law or that conduct business in the commonwealth (Virginia Department of Taxation (VDT), 2014b). Unfortunately VDT does not maintain records of tax revenues by industry-classification (Josephs, 2014). We estimate the annual corporate income tax paid by the coal industry with a method similar to that used by Downstream Strategies (2012). This involves assigning a proportion of the total annual corporate income tax collected by VDT to firms in the coal industry based on the proportion of the private industry Gross State Product (GSP) produced by the coal industry. Appendix 4A illustrates this methodology. The Commonwealth of Virginia received an annual average of $784.17 million in revenue from the corporate income tax in from FY2009 through FY2012 (VDT, 2009; VDT, 2010a; VDT, 2011a; VDT, 2012a). $4.59 million of this amount is estimated to have been paid by the coal industry.

State Sales Tax

Virginia levied a sales tax of five percent of the value of retail sales of goods and services until FY2014 (VDT, 2012d).[16] Four-fifths of this tax revenue was retained by the commonwealth and one-fifth was provided to the local government (VDT, 2012d). The portion of a sales tax that can be considered to be paid by the buyer vs. the portion paid by the seller depends on the price elasticity of demand[17] for the good or service being produced. If the demand for the good or service is relatively 'inelastic' – such as for a product without easy substitutes, a good example being gasoline – the buyer pays a higher proportion of the increased cost (relative to the market price) than the seller as a result of the sales tax. When demand is 'elastic' – such as for a good which has many near-substitutes – a larger proportion of the tax incidence is borne by the seller rather than the buyer. Because an accurate estimation of the price elasticity of Virginia-produced coal is beyond the scope of this project, we will assume that the seller of the coal pays all of the

[16]The retail sales tax increased after July 1, 2013, but this is outside the period of our analysis.
[17]'Price elasticity of demand' is defined as the proportional change (in a negative or decreasing direction) of the quantity of a good demanded when that price of the good rises by one percent. As an example, if the price elasticity of coal produced and sold in Virginia was 0.5, this would indicate that for a price that is one percent higher than the previous price, the amount of coal demanded would decrease by one-half of a percent. Given that Virginia's sales tax was five percent in FY2011, and assuming that the entire tax is pushed onto consumers with higher prices, this would mean that the increase in price above the market price caused by the sales tax would decrease sales by 2.5 percent, all else equal.

sales tax. Essentially, this assumption means that at the margin, purchasers of Virginia coal will buy from other nearby alternatives, such as from West Virginia or Kentucky sources (or depending on the market, Powder River Basin sources), if the price increases. Although this assumption is not fully accurate, this estimate will provide a ballpark figure for the taxes collected on the sale of coal produced in the state of Virginia, which would not occur if not for the existence of the Virginia coal industry.

A methodology similar to the one used by Downstream Strategies (2012) is used to estimate the annual sales taxes paid by the coal industry. Although the VDT does not keep precise records on the amount of sales tax paid by each industry, it does maintain records on the value of sales tax-eligible sales reported by each general industry-type (in this case, the non-oil and gas mining industry). We use the average annual taxable sales from CY2009 through CY2013 and adjust the value for the proportion of production value attributable to the coal industry. Multiplying this value by the sales tax rate provides an estimate for the sales tax revenue attributable to the coal industry. This methodology is enumerated in Appendix 4B. The final result is that the coal industry is estimated to have paid $10.37 million in sales tax to the commonwealth annually from CY2009 through CY2013.

Coal Mining Permit and Licensure Fees

Coal mining firms pay fees to the Virginia Department of Mines, Minerals, and Energy (VDMME) for permitting and licensure of mines, training of coal miners, and NPDES permits (Kesterson, 2014).[18] The yearly fees received by VDMME from 2009 through 2013 are shown in

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[18]NPDES stands for the National Pollutant Discharge Elimination System. This regulation is part of the Clean Water Act and requires facilities to obtain authorization to discharge polluted water directly into surface waters, such as streams (US EPA, 2015).

Table 4-1. Coal mine permit fees provided the majority of the average $1.58 million collected annually by VDMME, with NPDES fees accounting for nearly another third of the total.

Vehicle Registration Fees

Vehicle registration fees for coal hauling trucks are another means through which the coal industry contributes to the Virginia budget. The Virginia Department of Motor Vehicles (VDMV) provided data on the number of coal trucks that received overweight permits in CY2013 (Davis, 2014).[19] Of the 957 trucks permitted, 809 (almost 85 percent) were five- or six-axle tractor-semitrailers and 148 (15 percent) were three- or four-axle single-unit trucks (i.e.: dump trucks).[20] The registration fee for each kind of truck depends upon its weight capacity. A reasonable estimation would be to assume that the tractor-semitrailer trucks pay $1329.50, which corresponds to a vehicle with a Gross Vehicle Weight (GVW) of 80,000 lb. (VDMV, 2010).[21] We assume that coal-hauling dump trucks are permitted a GVW of 61,500 lb., which corresponds to an annual permit fee of $975 (VDMV, 2010) (see Appendix 4C for a full discussion of the methodology used). All trucks are assumed to pay the Virginia Road Tax of $150 in addition to their weight-based registration fees (VDMV, 2010). Overweight hauling permit fees would also apply, but the VDMV issues overweight hauling permits free of charge to

[19]CY2013 was the only full-year data available from VDMV.
[20]The vast majority of coal-hauling trucks are either six-axle tractor-semitrailers (~83%) or four-axle dump trucks (~12%). For simplicity, we assume that all tractor-trailers are six-axle trucks (this does not affect the resulting estimated value) and that all dump trucks are four-axle trucks (this only marginally affects the final estimated value of vehicle registration fees).
[21]80,000 lb. is the standard legal GVW permitted to travel on the federal highway system. Greater vehicle weights require specialized permits. A majority of the tractor-trailer combinations, especially the five- and six-axle trucks, used for freight travel would be registered to meet this GVW requirement. Therefore, all five- and six-axle coal hauling tractor-trailers are assumed to pay the truck registration fee corresponding to the maximum federal highway vehicle weight. It should be noted that although Virginia law prohibits coal-hauling trucks from operating on interstate highways when they exceed the standard highway loading requirements, they could potentially travel on interstate highways when they are not loaded, which provides support for this methodology.

coal hauling trucks.[22] The final estimate of registration fees paid by coal hauling trucks to the VDMV in CY2013 is $1.4 million. We assume this number reflects the typical annual registration fee collected and use it as an estimate for CY2011 as well.

Vehicle Fuel Taxes

Virginia also collects taxes from the coal industry in the form of fuel taxes paid by coal hauling trucks. We focus on diesel fuel, since this is likely the fuel used by most coal trucks. The commonwealth levied a $0.175 per gallon sales tax on diesel fuel sold in the state in CY2011 (VDMV, 2014b). Our estimates indicate that in the southwestern coal county region, coal hauling trucks travelled approximately 17.56 million miles in the same year (See Appendix 4-D). Research by government (US DOT, 2014) and academic (Tolliver, Lu, and Benson, 2013) sources indicate that the recent national average fuel economy for trucks hauling freight was around 5 miles per gallon. This corresponds to approximately 3.49 million gallons of diesel fuel consumed in CY2011 by coal hauling trucks (see Appendix 4D for a full discussion of the methodology used). The corresponding value of the sales tax collected on these fuel sales is around $611,000.

Mined Land Reclamation Funding

The US Congress enacted the Surface Mining Control and Reclamation Act (SMCRA) in 1977. The SMRCA created the US Office of Surface Mining Reclamation and Enforcement (US OSMRE) which manages programs regulating existing coal mining operations to ensure public safety. SMRCA also enacted severance taxes on contemporary US coal production to fund the

[22]The overweight hauling fee for similar trucks hauling sand, gravel, or crushed stone is $70 per year. As such, this represents a relatively small additional fee compared to the standard truck registration fee (VDMV, 2013). If coal trucks were required to pay the fee for overweight hauling permits, these fees would have been less than $67,000 in CY2013.

reclamation of previously mined lands (US OSMRE, 2012b).[23] Originally these severance taxes were 31.5 cents per ton of surface-mined coal and 13.5 cents per ton of underground-mined coal, but starting in October 2012, these rates declined to 28 cents per ton for surface-mined coal and 12 cents per ton for underground-mined coal (US OSMRE, 2012b). Fifty percent of these severance taxes collected annually from coal mined in Virginia are remitted directly to the Commonwealth to be used in reclamation projects (US OSMRE, 2010a). Another thirty percent are to be provided by the US OSMRE to states based upon previous coal production history, while the remaining twenty percent is used by the US OSMRE to respond to emergencies and carry out cleanup activities in states lacking approved land reclamation programs (US OSMRE, 2010a).

In Virginia, the VDMME's Division of Mined Land Reclamation is primarily in charge of regulating coal mines and carrying out reclamation activities. Abandoned mine lands (AML's) which were mined prior to December 15, 1981 are eligible to be reclaimed under Virginia's Abandoned Mine Land program, which is funded in part through annual grants provided by the US OSMRE (VDMME, 2014a). Distributions from the US OSMRE are used both to fund regulation programs for contemporary mines as well as reclaim abandoned mining lands. As of September 2014, VDMME estimates that $99 million in funding is needed to reclaim the highest priority AML's in Virginia, in addition to the $109 million already spent (Kesterson, 2014). AML's can also be reclaimed by current coal mining companies 'remining' the abandoned

[23]Contemporary mining operations are required under the SMCRA to reclaim the mined areas to a specified standard. Mine operators are required to post a bond which will pay for reclamation activities if they fail to reclaim the mining land to the requisite standard. This means that contemporary mining operations, as a general rule, do not contribute to the environmental costs addressed by the Virginia DMLR's reclamation operations; thus, the severance taxes paid on contemporarily-mined coal in Virginia represent modern producers and consumers paying for the cost of coal mining externalities arising from mines in operation before 1981. The funds distributed to Virginia from the US OSMRE under the AML program therefore qualify as a subsidy provided to past coal mining operations paid by current coal producers and consumers.

mining land. See Appendix 9 for a discussion of remining and the substantial benefits it offers to the state.

Itemized distributions from the US OSMRE from FY2005 through FY2014 are shown in Table 4-2 (US OSMRE, 2005; US OSMRE, 2006; US OSMRE, 2007; US OSMRE, 2008; US OSMRE, 2009; US OSMRE, 2010c; US OSMRE, 2011; US OSMRE, 2012a; US OSMRE, 2013; US OSMRE, 2014). Annual US OSMRE distributions to Virginia rose markedly starting in FY2008, averaging $13.4 million during the FY2008 through FY2014 time period, reflecting the 2006 Amendments to the SMRCA. US OSMRE distributions to Virginia will likely decrease after FY2014 following the culmination of distributions from the Prior Balance Replacement Fund[24] (PBRF). The average annual distribution from FY2008 through FY2014 would have been about $9.25 million without PBRF funding. We use $13.4 million as our estimate of revenue that Virginia received from the coal industry due to the SMRCA in FY2011, but it is important to realize that this revenue stream is likely to be substantially smaller in the future.

Exclusive Tax Expenditures

Virginia tax code allows for two exclusive tax expenditures to be used by the coal industry (see Appendix 1B for a discussion on general vs. exclusive tax expenditures). These expenditures are the Coalfield Employment Enhancement Tax Credit (CEETC) and the Virginia Coal Employment and Production Incentive Tax Credit (VCEPITC). Both are refundable tax credits, meaning that they are “not limited by the amount of the taxpayer’s tax liability” (VDT, 2012a; VDT, 2010b), and their value is tied to each firm’s annual production of coal. The

[24]FY2014 was the last year of the Prior Balance Replacement Fund distributions, which represent disbursements from previously unappropriated funds. Virginia’s total Prior Balance Fund amount was $29.8 million and was paid out as annual payments of $4.26 million from FY2008 through FY2014 (US OSMRE, 2014).

CEETC may be claimed directly by the mineral rights owners (generally, the coal mining companies) while the VCEPITC is a credit that is provided to Virginia electricity generation firms that use Virginia-mined coal in their power plants. These firms may then allocate a portion or all of the tax credit back to the mineral rights owners. It is reasonable to attribute the total value of the CEETC as being a benefit provided by the Commonwealth to the coal industry,[25] while the VCEPITC may accrue either to electricity producers or the coal industry. Lacking better information, we apply the full value of the VCEPITC as a benefit to the coal industry (based on our prior assumption about elasticity of demand for coal sales), since the structure of the credit would allow the coal industry to sell coal to electricity producers at a lower price than otherwise feasible.[26]

The CEETC and VCEPITC may not be rolled over and claimed in later tax years (although the CEETC is deferred three years before it can be claimed), meaning that the claims in each year represent the actual value of the credit earned in that year (or in the case of the CEETC, three years previous). The value of each of these credits claimed from 2010 through 2013 is shown in Table 4-3 (VDT, 2010a; VDT, 2011a; VDT, 2012a; VDT, 2013a). Due to the varying quantity of coal mined over this time period - which dropped from 22.4 million tons of coal in CY2010 to 16.6 million tons of coal in CY2013 - we use the average value of these tax credits as the best estimate to apply to our study year of 2011. The average value of the CEETC

[25]The VCEETC provides a tax credit which can be directly claimed by the mineral rights owner based on the amount of coal mined from ‘thin coal seams’ ($2 per ton) and ‘thick coal seams’ ($1 per ton) using underground mining methods and surface mined coal ($0.40 per ton) as well as coal bed methane gas ($0.01 per million British Thermal Units (BTU)).

[26]The VCEPITC provides a tax credit worth $3 per ton of coal mined in Virginia which is purchased by a qualifying electricity generating firm. This credit may be transferred only to a “qualifying person with an economic interest in coal” – a mineral rights owner, in general (VDT, 2010b). This structure would allow Virginia coal producers to sell their coal at a discount up to $3 less per ton than they otherwise could, assuming that the electricity generator agreed to transfer part or all of the VCEPITC to the coal producer. Note that the electricity generating firm likely retains some of the benefit, making our estimate of the benefit provided to the coal industry by the Commonwealth somewhat inaccurate.

over these four years equals $29.55 million. The VCEPITC was not claimed in 2011 and 2012 and the value claimed in 2010 was withheld because of the small number of claimants. However, the value claimed in 2013, $59.45, million was substantial. We account for this by averaging the 2013 tax credit over the three-year period from 2011 to 2013 and using the resulting value, $19.82 million, as the best estimate of the value of the tax credit in our study year of 2011.[27] The total estimated annual value of exclusive tax expenditures is therefore $49.37 million.

Conclusion

Coal mining operations contribute funds to the Virginia budget through the corporate income tax and retail sales tax, as well as through coal mine and truck registration fees and the fuel sales tax. Virginia also receives funds through the US OSMRE for abandoned mine land reclamation programs. These funds, averaging $13.4 million annually from FY2008 through FY2014, represent the largest contribution of the contemporary coal industry towards Virginia's budget. The retail sales tax is the second-largest contributor of tax revenues, with the average annual collections from FY2009 through FY2013 estimated to be $10.37 million. The corporate income tax, coal mining fees, vehicle registration fees, and vehicle fuel taxes are substantially smaller, estimated to be $4.59 million, $1.58 million, $1.4 million, and $0.61 million in 2011, respectively. In total, the contemporary coal industry is estimated to have contributed $31.95 million to the Virginia budget in 2011 through tax revenues or permit fees.[28]

[27]We use the three year period from 2011 through 2013 over which to average this tax credit because the value of the credit claimed in 2010 is unknown. This means that if we included 2010 in our average we would be adding additional uncertainty into what is already a generalized estimate.

[28]This amount does not include funds paid to local governments or the Virginia Coalfield Economic Development Authority (VCEDA). These contributions are briefly detailed in Appendix 7, but are provided only for context since an investigation into the impact of the coal industry on local government budgets is beyond the scope of this report.

Our final estimate of pre-tax credit tax revenues is more than double the $15.1 million found by Downstream Strategies. The primary reason for this discrepancy is our inclusion of the Abandoned Mine Land funding from US OSMRE, which DS does not consider. We also include estimates of the fees paid by the coal industry for mining permits and vehicle registrations, as well as sales tax on fuel purchases. Conversely, we do not include the replacement of Virginia's funding for local education by coal severance taxes, as Downstream Strategies did, because it does not appear that local severance taxes affect the determination of the Standard of Quality (SOQ) funding (see Appendix 8 for further discussion). In the areas where we paralleled the Downstream Strategies methodology (corporate income taxes and sales and use taxes), we find our estimates are quite similar.

However, these estimated revenues are more than balanced out by the large value of exclusive tax credits provided to the coal industry. Subtracting the $49.37 million of estimated annual tax credits from the tax and fee revenues paid directly to Virginia[29], estimated to be $15.57 million, produces a net value of $33.8 million, of which 85% ($28.7 million) would be repaid to the coal industry as a refundable tax credit and 15% ($5.1 million) would be disbursed to the Virginia Coalfield Economic Development Authority, per Virginia tax law (VDT, 2010b). When the various state fees and disbursements from the US OSMRE are subtracted from the estimated $28.7 million refundable tax credit, the estimated net tax revenue accruing to Virginia from the coal industry amounted to a loss of $12.3 million – the tax credits cause the coal industry to be a net drain on the Virginia state budget even before direct governmental expenditures are considered. Table 4-4 provides a summary of the estimated revenues related to

[29]Virginia tax law allows those firms using the CEETC and VCEPITC to use it to defray any taxes paid to the state. We count the corporate income tax, retail sales and use tax and fuel sales tax as taxes that are defrayed by the credit. We assume that the credit cannot be applied to mining permit fees or vehicle registration fees.

the coal industry collected by Virginia's state government and a comparison with Downstream Strategies' findings.

Virginia Department of Mines, Minerals and Energy Coal Industry Fees paid during FY2009 - FY2013					
Fee	**2009**	**2010**	**2011**	**2012**	**2013**
Coal Mine Licenses	40,352.00	43,550.00	78,230.00	81,200.00	73,512.00
Training & Exam Fees	108,216.00	94,551.00	138,216.00	143,835.00	93,570.00
Permit Fees	1,084,442.00	953,171.00	778,530.00	763,546.00	916,932.00
NPDES Fees	536,383.00	579,045.00	449,965.00	397,638.00	554,460.00
Total	$1,769,393.00	$1,670,317.00	$1,444,941.00	$1,386,219.00	$1,638,474.00

Source: Virginia Department of Mines, Minerals, and Energy

Table 4-1: Coal Industry Fees Paid to VDMME

US Office of Surface Mining Reclamation and Enforcement Funding to Virginia's Abandoned Mine Land Programs

Fiscal Year	State Share Distribution[1, 5]	Historic Coal Funds Distribution[2, 5]	Prior Balance Replacement Funding[3, 5]	Appalachian Clean Streams Program Distribution[4, 5]	Emergency Distributions[4, 5]	Regulatory Grant Distribution[6]	Total Distributions from US OSMRE
2005	$1,882,197	$1,725,130	$0	$172,044	$1,850,000	-[9]	$5,629,371
2006	$1,768,049	$1,639,778	$0	$182,336	$1,700,000	-[9]	$5,290,163
2007	$1,745,840	$1,659,821	$0	$182,336	$1,700,000	$3,394,421	$8,682,418
2008	$1,448,470	$1,476,851	$4,257,059	-[7]	$1,700,000	$3,925,342	$12,807,722
2009	$1,072,495	$1,693,431	$4,257,059	-[7]	$1,200,000	$3,913,498	$12,136,483
2010	$1,497,057	$2,897,781	$4,257,059	-[7]	$1,200,000	$3,911,857	$13,763,754
2011	$1,552,833	$3,256,093	$4,257,059	-[7]	$0	$3,720,089	$12,786,074
2012	$2,047,607	$5,026,129	$4,257,059	-[7]	-[8]	$3,895,866	$15,226,661
2013[10]	$1,781,986	$4,549,781	$4,039,949	-[7]	-[8]	$3,752,558	$14,124,274
2014[10]	$1,261,619	$3,733,968	$3,950,553	-[7]	-[8]	$3,791,502	$12,737,641

Footnotes:

1 - The 'State Share' of the SMCRA is funded by a 50% share of the SMRCA severance tax collection. These funds are automatically disbursed to states with approved AML programs (US OSMRE, 2010a).

2 - The 'Historic Coal Fund Distribution' is funded by a 30% share of the severance taxes collected through the SMCRA. Thes funds are disbursed to states with a history of coal production prior to the passage of SMCRA and a need for additional AML program funds (US OSMRE, 2010a).

3 - The funding distributed through the Prior Balance Replacement Fund from 2008 through 2014 was based on previously unappropriated funds (US OSMRE, 2010a).

4 - These distributions are appropriated based on specific applications for funding through various programs rather than through the mandatory distribution process (US OSMRE, 2010a; US OSMRE, 2011).

5 - Under Title IV of the SMRCA, the US OSMRE provides grants to fund Abandoned Mine Land programs (US OSMRE, 2010a).

6 - Under Title V of the SMRCA, the US OSMRE provides grants to fund state-run regulatory programs (US OSMRE, 2010b).

7 - There was no new funding reported for the Appalachian Clean Streams Program by the US OSMRE grant distribution summaries after 2007.

8 - Emergency distribution funding was not reported in US OSMRE grant distribution summaries after 2007 and the most recent Annual Report available covers FY2011.

9 - Data on Regulatory Grant Distributions is not available for years before 2007.

10 - Funding for Abandoned Mining Land grants was reduced by 5.1% in 2013 and 7.2% in 2014 as part of the sequestration legislated by the Balanced Budget and Emergency Deficit Control Act of 1985 and the Budget Control Act of 2011 (US OSMRE, 2013; US OSMRE, 2014).

Source: US OSMRE.

Table 4-2: Virginia Abandoned Mine Land Program Funding from US OSMRE

Virginia Coal Industry Exclusive Tax Credits			
Year	**Annual Virginia Coal Production (Millions of Tons)**	**Coalfield Employment Enhancement Tax Credit: Total Value Claimed**	**Virginia Coal Employment and Production Incentive Tax Credit: Total Value Claimed**
2010	22.385	$44,136,297	*
2011	22.523	$27,250,091	-
2012	18.965	$24,972,670	-
2013	16.619	$21,841,032	$59,449,214

* - "Data for this credit is not available for release because fewer than four returns claiming the credit were processed in FY2010" (VDT, 2010a).

Source: US Energy Information Agency and Virginia Department of Taxation

Table 4-3: Exclusive State Tax Credits Available to the Virginia Coal Industry

Virginia's Annual Revenues Related to the Coal Industry		
Type of Tax or Fee	**Downstream Strategies FY2009 Estimates[1]**	**Partridge/Farren FY2011 Estimates[2]**
Corporate Income Tax[3]	$2,110,000	$4,587,394
Sales and Use Tax[3]	$6,360,000	$10,374,598
Replacement of State Revenues for Local Education[4]	$6,600,000	$0
Coal Mine Permit Fees[5]	$0	$1,581,869
Vehicle Registration Fees[5]	$0	$1,400,000
Fuel Sales Tax[5]	$0	$611,000
Abandoned Mine Land Program Funding[5]	$0	$13,400,000
Sub-Total:	$15,070,000	$31,954,861
Aggregate Coal Industry Exclusive Tax Credits	$35,720,000	$49,370,000
Net Impact on State Budget Revenue:[6]	-$17,110,000	-$12,345,587.80

Footnotes:

1 - Downstream Strategies only considers revenues accruing to the Virginia General Assembly's General Fund or Transportation Fund.

2 - Partridge/Farren account for coal industry tax payments collected by any unit of the Virginia state government.

3 - Downstream Strategies and Partridge/Farren use similar methodologies to estimate these revenues.

4 - Downstream Strategies and Partridge/Farren use different methodologies to estimate these revenues.

5 - Downstream Strategies did not account for this tax or fee revenue.

6 - Our calculation of the net impact takes into account the fact that the Virginia Coalfield Economic Development Authority receives 15% of the value of the exclusive coal industry tax credits which exceed a company's tax liability.

Source: Virginia Dept. of Taxation, Virginia Dept. of Mines, Minerals, and Energy, Virginia Dept. of Motor Vehicles, US Office of Surface Mining Reclamation and Enforcement, and Downstream Strategies (2012).

Table 4-4: Comparison of Coal Industry-related Revenue Estimates

5. Coal Hauling Roadway Impacts

Introduction

The impact of coal hauling operations on the Commonwealth's roadways merits special consideration, as this is an area in which the coal industry may be responsible for significant costs. Although the state's share of spending related to reconstruction of coal hauling roads is quantified elsewhere in this report, that value represents expenditures on roadway construction, which may or may not fully cover the actual roadway damage caused by coal hauling trucks. This section provides a methodology through which an estimate of this damage can be quantified and in doing so extends the body of knowledge involving the quantification of roadway impact costs attributable to heavy trucks.

Coal Hauling Operations

Almost all coal mined in southwestern Virginia is shipped out of the region via railways. Before this can be accomplished, however, the coal must be transported from the mine to a preparation plant to purify the coal. Most often the preparation plants are located so that the coal can then be loaded onto rail cars directly after processing. Some mines have preparation plants and railway loadout facilities onsite, but in most cases the coal is transported for some distance over public roadways using large coal hauling trucks.

Coal hauling trucks are regulated by the Virginia Department of Motor Vehicles (VDMV), which registered 957 coal hauling trucks in 2013 (Davis, 2014).[30] The vast majority of trucks used to haul coal were six-axle tractor-semitrailers (83%) while the next largest minority

[30] We assume that the choice of truck types used in hauling coal is relatively unchanging over time, meaning that the coal hauling truck types used in 2013 are a reasonably accurate measure for the trucks used in our study year of 2011.

consisted of four-axle dump trucks (12%).[31] These trucks, in particular the six-axle tractor-semitrailers, are not a typical type of truck used for ordinary shipments of goods – they are specifically intended for hauling minerals and debris. In addition, the coal hauling permit required for these trucks allows them to exceed the weight limits governing most other trucks.[32] We assume that all coal trucks are loaded to their allowable weight limit and that the weight is distributed realistically between the truck axles (see Appendix 5A for more details). We use this information to estimate the pavement damage that each type of coal hauling truck produces, also known as the Load Equivalency Factor (LEF), which is measured in "ESAL's".[33] We find that a fully loaded six-axle tractor-semitrailer has a LEF of 5.3 ESAL's while a four-axle dump truck is responsible for around 2.8 ESAL's.

Pavement Design and Cost

We assume that the primary[34] roadways used as coal hauling routes are built to a thickness of 9.5-inches while secondary[35] roads are built to a 7-inch thickness. These values roughly match roadway thicknesses found by Freeman and Clark (2002) in a survey of coal region roads.[36] These thicknesses correspond to primary roadways having a damage capacity of

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[31]We treat uncounted tractor-semitrailers as if they were six-axle tractor-semitrailers (2% of the total registered coal hauling trucks) and uncounted dump trucks as if they are four-axle dump trucks (3% of the total registered coal hauling trucks), which results in a final ratio of 85%/15%, respectively.

[32]The permitted weights for coal hauling trucks are 110,000 pounds (six-axle tractor-semitrailers) and 70,000 pounds (four-axle dump trucks) respectively (VDMV, 2013). The normal weight limit for five- and six-axle tractor-semitrailers is 80,000 pounds and 54,000-80,000 pounds for four-axle dump trucks, depending on distance between front and rear axles (VDMV, 2013).

[33]The Load Equivalency Factor is measured in "Equivalent Single-Axle Loads" (ESAL's). ESAL's are a standardized engineering measure of the damage done to pavement by vehicles. For reference, a standard five-axle tractor-semitrailer (known colloquially as an "18-wheeler") weighing 80,000 pounds has a LEF of 2.37 ESAL's while the contribution of passenger cars to pavement damage is essentially negligible (USDOT, 2000).

[34]'Primary roads' are those roads which focus serving the travel demand for movement and speed. This role is generally filled by federal and state highways.

[35]'Secondary roads' are those roads which focus on serving the travel demand for land access. This role is generally filled by county and local roads.

[36]Freeman and Clark (2002) found approximately half of the pavements were 6- to 8-inches thick and another third were 9-inches thick, with the rest being 10- to 12-inches thick.

6,000,000 ESAL's while secondary roads have a damage capacity of 600,000 ESAL's.[37] Each passage of a heavy truck over the pavement subtracts from the pavement's remaining damage capacity, which represents the practical lifetime of the pavement. When the damage capacity of the pavement reaches zero, the roadway would be so degraded that it would require a full reconstruction. See Appendix 5B for a detailed description of pavement design methodology.

We assume the roadway width to be 18 feet for secondary roads and 20 feet for primary roads, based on data from VDOT (2011b). Multiplying the asphalt thickness by the roadway width and 5,280 feet provides the volume of asphalt required for pavement reconstruction per roadway mile. Combining this value with the density and material cost of asphalt creates a basic estimate of roadway reconstruction costs.[38] We find that pavement material cost is $640,000 per mile for primary roadways and $420,000 per mile for secondary roadways. We do not have information on other costs associated with roadway reconstruction, such as shoulder construction or traffic control, which can vary by roadway; our estimate of the dollar value of roadway damage relates only to the cost of pavement materials needed to restore the roadway to its previous state and not to any actual construction project. Accordingly, our estimate might serve as a lower bound on the cost of roadway damage due to coal hauling operations.

Pavement Damage Attributable to Coal Hauling

We use publicly-available information concerning coal hauling traffic and the quantity of coal production in order to obtain estimates of the pavement damage done by coal transport over public roadways. VDOT (2012b) provides traffic data by vehicle type which we use to estimate

[37]The strength of a pavement is a nonlinear function of its thickness, which explains the substantial increase in pavement damage capacity for a seemingly mild increase in thickness.
[38]We used a pavement cost of $105 per ton of asphalt applied as provided by VDOT (Hill, 2014). The cost of asphalt pavement can vary widely though, depending on the change in price of the asphalt binding materials, which are petroleum–based and can fluctuate significantly from year to year.

the total distance traveled by each type of coal hauling truck (see Table 5-2 and 5-3). We also use data on the total coal tonnage produced in each county provided by the Virginia Center for Coal and Energy Research (VCCER) (2014b) to estimate the number of coal hauling trips needed to transport the coal from the mine to the preparation plant/load-out facility (see Table 5-6). This allows for an estimation of the per-mile pavement damage due to coal hauling. Combining the number of hauling trips with the total vehicle-miles traveled by coal hauling trucks also allows an estimate of the average coal hauling trip length, 12.2 miles.[39]

We assume that factors affecting traffic levels (commuting patterns, shipping, etc.) are generally proportional to the size of the population, but the southwestern coal counties experience a substantially higher share of truck traffic associated with coal hauling than the rest of the commonwealth. The coal region contained 2.5% of Virginia's population in 2011, but VDOT traffic estimates indicate that it was responsible for 6.9% of all vehicle-miles traveled by four-axle dump trucks and 40.4% of all six-axle tractor-semitrailer traffic in the same year (see Table 5-1). This imbalance in traffic proportions is likely caused by coal industry operations and provides some confidence in the ability to estimate the impacts of coal-hauling trucks using VDOT traffic data.

In order to account for the normal traffic of four-axle dump trucks and six-axle tractor-semitrailers that would be present in each county, we subtract out the population-weighted vehicle-miles traveled by these truck types in Scott County (see Tables 5-2 and 5-3). Scott County, while being part of the southwestern coal region, has not produced coal since 1996 and provides the best counterfactual for the other coal-producing counties since it shares similar

[39]We are able to estimate only the regionally-based value of the average coal hauling trip length because of the likelihood of coal shipments between counties.

economic, cultural, demographic, and geographic characteristics. We assume that the resulting vehicle-miles per-capita attributed to these truck types represent each county's traffic related to the coal industry (see Tables 5-2 and 5-3).

The product of the LEF for each truck type and the estimated vehicle-miles traveled by that truck type attributed to coal hauling provides a county-specific estimate of the total roadway damage attributable to coal hauling operations in 2011 (see Tables 5-4 and 5-5). Comparing this estimate with the damage capacity of our assumed roadway design and the pavement material costs provided by VDOT allows an estimation of the dollar value of pavement damage done by coal hauling operations in 2011 equal to $10.3 million. See Appendix 5C for a detailed description of this methodology.

We also estimate the cost of pavement damage from coal hauling by the coal's county of origin, shown in Table 5-6 and described in Appendix 5D, which illustrates a different way of arriving at the same total cost of pavement damage. We assume that 100% of this coal is shipped over public roadways[40] using a mix of coal hauling trucks proportionally equivalent to the data received from the VDMV (Davis, 2014), which generates about 720,000 coal hauling trips. The total pavement damage depends on the length of coal hauling route and the proportion of primary road mileage to secondary road mileage along that route. We estimate that the average coal hauling trip in 2011 was 12.2 miles long, which corresponds with 43.1 million ESAL's of pavement damage (valued at $10.3 million) across Virginia's coal region.

[40]Since not all coal is transported over public roadways – some mines have preparation plants and/or railway load-out facilities on-site – this assumption is not fully correct. However, the number of preparation plants permitted by the US Mine Safety and Health Administration (2014) is relatively small compared to the number of mines in Virginia. Therefore, it seems likely that much of the coal is shipped from the mine to the plant via public roads.

Lastly, an upper-bound can be estimated for the pavement damage attributable to coal hauling operations. Virginia limits coal hauling trucks to operate only within 85 miles of a preparation plant or railway loading dock, which effectively limits the allowable hauling distance. Using this value as the transport distance for all coal production results in an upper-bound estimate of the pavement damage costs from coal hauling in 2011, $71.7 million.[41]

Discussion

The pavement damage costs seem to be borne primarily by the secondary road networks ($6.7 million), rather than primary road networks ($3.6 million), but this may be partly a consequence of the thinner pavement thickness assumed for secondary roads. When the results from the primary and secondary road networks are aggregated, Buchanan County shows the highest roadway impact costs ($3.3 million), followed by Wise County ($2.5 million), Russell County ($2.2 million) and Dickenson County ($2.0 million). Tazewell and Lee Counties show relatively low coal hauling traffic volumes and impact costs, which matches expectations since these counties produce very little coal compared to Buchanan, Wise, and Dickenson Counties. Russell County shows higher than expected roadway costs given the amount of coal it produces, but it borders Buchanan, Wise, and Dickenson Counties and may receive cross-border coal hauling traffic from these counties.

The estimated pavement damage is similar to the amount of Virginia's roadway expenditures discussed in Section 3 of this report. Based on data from VDOT (Hill, 2014), the coal counties allocated approximately $8.3 million from coal severance tax revenues to road reconstructions projects, which was then matched with $6.1 million in VDOT funding. Although

[41]It should be noted, however, that the upper-bound of coal hauling pavement damage is likely substantially larger than the actual damage value since the hauling limit of 85 miles corresponds to transporting every ton of coal across the entire breadth of the coal region, which would be very expensive for the coal producers.

this total amount is $4.1 million larger than the $10.3 million in pavement damage, the county/VDOT expenditures would include other construction costs other than pavement materials. However, the VDOT reconstruction projects were mainly focused on rehabilitating secondary roads affected by coal hauling. This may mean that the pavement damage costs occurring on primary roads which are used as coal hauling routes are not being incorporated into the cost of hauling coal and may represent an implicit subsidy by Virginia for the coal industry if our $10.3 million estimate is correct.

One aspect that is immediately apparent from the analysis is that a slightly thicker pavement contributes exponential growth in the pavement strength. For example, shifting from a 7-inch thick asphalt pavement (our secondary roadway thickness assumption) to a 9.5-inch thick pavement (our primary roadway thickness assumption) increases the pavement damage capacity from 600,000 ESAL's to 6,000,000 ESAL's. Put another way, a 36% increase in pavement thickness is estimated to increased pavement damage capacity by 900%. Communications with VDOT (Hill, 2014) indicate that standard practice is to use approximately 2-inch thick asphalt overlays to rehabilitate crumbling pavements on coal hauling routes. If this same asphalt thickness were instead added to the initial pavement construction, the resulting increase in pavement strength would likely be much larger than using it for the overlay on top of degraded pavement later. In short, a shift towards using thicker pavements at the initial pavement construction stage could result in significant cost savings over the course of the pavement's life.

Conclusion

Transportation of coal over public roads and the corresponding pavement damages represent a substantial cost attributable to the coal industry, but one which has not been previously quantified. We emphasize that our results are best understood from an aggregated regional perspective rather than a county-level viewpoint, since data limitation issues inhibit accurate estimation of roadway impacts for hauling routes that cross county borders.

We estimate that coal hauling traffic caused $10.3 million in pavement damage costs across the coal region in 2011, which is substantially higher than the $1.5 million estimated by Downstream Strategies. This value can be considered a lower-bound for actual reconstruction costs, since it only incorporates the value of the pavement damaged by the passage of heavy coal trucks. However, we believe that expressing the effect of coal hauling in terms of the pavement costs needed to absorb the damage is the best way to quantify the effect of coal hauling. If VDOT could anticipate which roadways will receive the majority of coal hauling damage and add pavement thickness to those during the initial construction stage, the monetary costs associated with pavement damage caused by coal trucks could be substantially reduced and the related roadway construction costs (shoulder construction, maintenance of traffic, etc.) attributed to regular and expected rehabilitation requirements.

We also estimate an upper-bound on the pavement damage from coal hauling activities, which removes the dependence of our analysis on VDOT’s estimation of coal truck traffic. This upper bound of $71.7 million is improbably high, however, as it uses an 85 mile coal hauling distance, which is unlikely to occur, especially for all of the coal mined in Virginia.

Table 5-1: Comparison of Virginia's Coal Region with the Rest of the Commonwealth (2011)

Region	County Population	Percentage of State Population	Primary Roads Percentage of Statewide DVMT		Secondary Roads Percentage of Statewide DVMT	
			Veh. Type 7	Veh. Type 10	Veh. Type 7	Veh. Type 10
Buchanan County	23,869	0.29%	1.00%	1.46%	2.06%	22.89%
Wise County	45,412	0.56%	1.66%	16.81%	0.78%	7.42%
Dickenson County	15,784	0.19%	0.44%	11.35%	0.68%	6.56%
Russell County	28,713	0.35%	1.63%	4.40%	0.92%	13.48%
Tazewell County	44,696	0.55%	1.61%	2.54%	0.21%	0.37%
Lee County	25,610	0.32%	0.87%	1.32%	0.11%	0.21%
Scott County	22,963	0.28%	0.35%	0.47%	0.23%	0.20%
Total, Coal Region:	207,047	2.55%	7.57%	38.34%	4.99%	51.11%
Total, Rest of Virginia:	7,897,337	97.45%	92.43%	61.66%	95.01%	48.89%

Source: National Cancer Institute SEER Program Population Data and Virginia Dept. of Transportation.

Table 5-2: Estimates of Coal Hauling Traffic on Primary Roadways in Virginia's Coal Region (2011)

Region	Primary Roads DVMT		Primary Roads Per Capita DVMT		Primary Roads DVMT Attributed to Coal Industry	
	Veh. Type 7	Veh. Type 10	Veh. Type 7	Veh. Type 10	Veh. Type 7	Veh. Type 10
Buchanan County	1,316	1,360	0.055	0.057	843	902
Wise County	2,180	15,675	0.048	0.345	1,281	14,803
Dickenson County	584	10,578	0.037	0.670	271	10,275
Russell County	2,145	4,100	0.075	0.143	1,577	3,549
Tazewell County	2,114	2,365	0.047	0.053	1,229	1,507
Lee County	1,139	1,226	0.044	0.048	632	735
Scott County	455	441	0.020	0.019	0	0
Total, Coal Region:	9,933	35,746	0.048	0.173	5,833	31,771
Total, Rest of Virginia:	121,310	57,479	0.015	0.007	-	-

Source: National Cancer Institute SEER Program Population Data, Virginia Dept. of Transportation, and authors' calculations.

Table 5-3: Estimates of Coal Hauling Traffic on Secondary Roadways in Virginia's Coal Region (2011)

Region	Secondary Roads DVMT		Secondary Roads Per Capita DVMT		Secondary Roads DVMT Attributed to Coal Industry	
	Veh. Type 7	Veh. Type 10	Veh. Type 7	Veh. Type 10	Veh. Type 7	Veh. Type 10
Buchanan County	971	4,139	0.041	0.173	860	4,102
Wise County	366	1,342	0.008	0.030	154	1,272
Dickenson County	320	1,185	0.020	0.075	247	1,161
Russell County	434	2,438	0.015	0.085	300	2,394
Tazewell County	100	66	0.002	0.001	0	0
Lee County	54	37	0.002	0.001	0	0
Scott County	107	35	0.005	0.002	0	0
Total, Coal Region:	2,352	9,242	0.011	0.045	1,561	8,929
Total, Rest of Virginia:	44,739	8,840	0.006	0.001	-	-

Source: National Cancer Institute SEER Program Population Data, Virginia Dept. of Transportation, and authors' calculations.

Table 5-4: Impact of Coal Hauling on Primary Roadways in Virginia's Coal Region (2011)

Region	Estimated Total Coal Hauling Mileage on Primary Roadways	Estimated Total Pavement Damage (ESAL's) due to Coal Hauling on Primary Roadways	Estimated Total Pavement Damage Cost of 2011 Coal Hauling Traffic on Primary Roadways
Buchanan County	637,120	1,302,058	$ 138,538
Wise County	5,870,897	14,970,982	$ 1,592,897
Dickenson County	3,849,504	10,076,943	$ 1,072,176
Russell County	1,870,744	4,235,184	$ 450,619
Tazewell County	998,715	2,083,510	$ 221,683
Lee County	498,604	1,032,018	$ 109,806
Scott County	0	-	-
Total, Coal Region:	13,725,585	33,700,695	$ 3,585,718

Source: Authors' calculations.

Table 5-5: Impact of Coal Hauling on Secondary Roadways in Virginia's Coal Region (2011)

Region	Estimated Total Coal Hauling Mileage on Secondary Roadways	Estimated Total Pavement Damage (ESAL's) due to Coal Hauling on Secondary Roadways	Estimated Total Pavement Damage Cost of 2011 Coal Hauling Traffic on Secondary Roadways
Buchanan County	1,811,068	4,405,505	$ 3,132,911
Wise County	520,696	1,309,077	$ 930,931
Dickenson County	513,766	1,248,548	$ 887,887
Russell County	983,242	2,468,111	$ 1,755,161
Tazewell County	0	-	-
Lee County	0	-	-
Scott County	0	-	-
Total, Coal Region:	3,828,772	9,431,242	$ 6,706,890

Source: Authors' calculations.

Table 5-6: Impacts of Coal Production by County on Roadways in Virginia's Coal Region (2011)

Region	2011 Coal Production (Tons)	Estimated number of coal hauling trips	Estimated Total Pavement Damage Cost from 2011 Coal Production by County assuming an average transport distance of 12.2 miles	Estimated Total Pavement Damage Cost of 2011 Coal Production by County assuming the maximum transport distance of 85 miles
Buchanan County	9,315,000	300,484	$ 4,286,286	$ 29,863,468.71
Wise County	9,213,000	297,194	$ 4,239,351	$ 29,536,461.33
Dickenson County	1,331,000	42,935	$ 612,458	$ 4,267,125.80
Russell County	881,000	28,419	$ 405,391	$ 2,824,446.16
Tazewell County	1,118,000	36,065	$ 514,446	$ 3,584,257.44
Lee County	510,000	16,452	$ 234,676	$ 1,635,036.93
Scott County	0	-	-	-
Total, Coal Region:	22,368,000	721,548	$ 10,292,608	$ 71,710,796.37

Source: Virginia Center for Coal and Energy Research and authors' calculations.

6. Conclusion

We estimate, in accounting for all current state-based revenues and expenditures related to the coal industry, that the presence of the coal industry resulted in a net loss of $36.7 million to the Virginia state budget in 2011. This effect is primarily caused by the Coalfield Employment and Enhancement Tax Credit and the Virginia Coal Employment and Production Incentive Tax Credit. These exclusive tax credits combined are estimated to total $49.37 million in FY2011. $5.1 million of this amount is estimated to fund the Virginia Coalfield Economic Development Authority (VCEDA), with the remaining $44.3 million serving as a benefit to the coal industry. Without these exclusive tax credits, the estimated revenues the state receives from the coal industry, $31.95 million, would be larger than the state's expenditures related to the coal industry, $24.4 million. We do not argue one way or the other whether these figures are appropriate for the state, but leave that to further analysis and public discourse.

It is important to note that the coal industry also contributes a substantial amount of funding to the southwestern coal region counties through various local taxes. We provide a brief discussion of one of these taxes, the coal severance tax, in Appendix 7. Based on data provided by VCEDA, we estimate that the average annual collection of local severance taxes amounted to $38.8 million, of which $4.85 million was provided to VCEDA. Based on data provided by VDOT, we estimate that another $8.3 million was allocated annually by the coal counties to coal hauling road rehabilitation efforts. Part of the remaining annual balance, $25.65 million, is used for water infrastructure improvement projects and half of the original amount accrues to the general fund of the municipality (CARN, 2012). To the extent that this funding replaces state funding that might otherwise occur represents a benefit provided to the state by the coal industry, but we know of no data available that can accurately estimate this benefit, if it exists.

The coal industry is also working with the Virginia Department of Transportation in 'coal synergy' construction methods to reduce the state's cost of constructing the Coalfields Expressway (US Route 121). A discussion of this project is provided in Appendix 6. We do not count the potential benefits this construction method would provide to the state in our primary analysis because of the early stages of this project. However, we believe that the substantial value they represent, estimated to be $70.0 million annually, is worth some consideration in the larger context surrounding the coal industry in southwestern Virginia.

The coal industry also provides substantial benefits to Virginia and the southwestern coal region by using 'remining' practices to reclaim abandoned mining lands (AML). This practice allows the Division of Mined Land Reclamation to focus their reclamation efforts on high-priority AML's which are unlikely to be reclaimed through remining and also addresses many low-priority AML's which wouldn't otherwise be reclaimed. We provide a discussion of this practice in Appendix 9 and estimate that it provides a value to the state of around $6.6 million per year.

The Virginia coal industry is an important part of the economy of the seven county southwestern region. However, coal production has declined by almost two-thirds since peaking in 1990, even with the presence of two lucrative exclusive tax credits. Increased competition with cheaper coal from Western sources, anticipated federal regulations regarding coal-fired power plants, and the revolution in shale gas extraction are likely to place ever-greater pressures on Virginia's coal producers in the future. Perhaps the most likely outcome will be continued declining domestic consumption of Virginia's coal and an increasing share of Virginia's falling coal production being purchased by international markets demanding high-quality metallurgical coal. Adaptation to the changing circumstances of domestic and international coal markets will be necessary if Virginia's coal industry is to avoid eventual stagnation or collapse.

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Appendix 1A – Summary of the Downstream Strategies Report

The Impact of Coal on the Virginia State Budget

We summarize the Downstream Strategies report below, listing their assumptions and limitations, many of which may apply to this report as well.

I. Direct Impacts of the Coal Industry on the Virginia State Budget

- The Downstream Strategies (DS) report, *The Impact of Coal on the Virginia State Budget,* explicitly only considers General Fund (GF) and Transportation Fund (TF) revenue and expenditures related to the coal industry.
- DS states that the coal industry also creates revenues for and receives expenditures from non-General Fund (NGF) accounts and individual agency budgets. However, the DS methodology did not consider coal industry-related NGF expenditures and revenues because the Virginia General Assembly can only make discretionary appropriations from the GF.
- DS also states that the coal industry generates revenue for county and city budgets as well and briefly considers these in an appendix.
- DS estimates TF revenues and expenditures occurring due to employment attributable to the coal industry. The report also estimates the value of Virginia Dept. of Transportation expenditures attributable to coal-hauling truck traffic.

A. State Government Revenues

- Summary: The DS report estimates that the coal industry contributed a total of $15.1 million to the Virginia state budget in FY2009 through direct tax collections or displaced education expenditures.

- Corporate income tax (GF) - The DS report estimates that the coal industry paid \$2.11 million in corporate income taxes in FY2009. Their estimation procedure takes the ratio of the coal mining industry's average value of annual production during CY2008 and CY2009 relative to non-government Gross State Product (GSP) and multiplies it by the average annual total corporate income tax revenues during CY2008 and CY2009.
    - This methodology is fairly general but provides an estimate that is roughly correct.
- Sales and use tax (GF) - The DS report estimates that the coal industry paid \$6.36 million in sales and use taxes into the GF in FY2009. The DS methodology uses the ratio of average annual production value of coal during CY2008 and CY2009 relative to the production value from all mining (minus 'oil & gas'), multiplied by the total taxable sales for mining (minus 'oil & gas'), multiplied by an effective sales tax rate of 2.6%.
    - DS's effective sales tax rate was obtained from a communication with the Virginia Department of Taxation (VDT) and is different than the official value of 4% or 5% because the DS methodology only considers the funds going to the GF.
    - Although the effective sales tax rate was provided by an official source, its inclusion does introduce measurement error into the final estimation. An error of ±0.1% in the effective sales tax would change the DS estimation of the total sales tax paid by the coal industry by \$0.25 million. Of course, such errors are to be expected in this type of estimation.

- Replacement of state revenues for local education using coal taxes (GF) - The DS report estimates that local coal taxes replaced $6.6 million in state Standards of Quality (SOQ) education funding in FY2009, representing a cost-savings to the commonwealth.
    - However, we have some concerns with how the DS methodology models the determination of SOQ funding, meaning that their estimate may be inaccurate.

B. State Government Expenditures (on-budget)

- Summary: The DS report estimates that the on-budget state government expenditures from GF-sourced funding related to the coal industry totaled $9.65 million in FY2009. State government TF expenditures attributable to the coal industry totaled $1.5 million.
- Virginia Dept. Of Mines, Minerals, and Energy (VDMME)
    - DS communication with VDMME indicated that 100% of the Division of Mines (DM) & Division of Mined Land Reclamation (DMLR) budget is coal industry-related ($4.1 million and $2.1 million respectively); 3.5% of the Division of Geology and Mineral Resources (DGMR) budget and 5% of the Division of Gas and Oil (DGO) budget were 'coal industry-related' ($60,000 and $40,000, respectively). DS applied the estimated proportion of coal-related expenditures from the GF to administrative costs for VDMME, estimating the administrative expense related to the coal-industry was $0.99 million.

- Virginia Dept. Of Environment Quality (VDEQ)
    - DS assumed that 5% of all GF contributions to VDEQ's budget were related to the coal industry. They did not provide reasoning for this assumption, which may produce measurement error in their final estimate.
    - The budgeted dollar amounts they report as being coal industry-related are: $1.26 million (environmental protection); $0.56 million (administrative costs); and $0.19 million (financial assistance programs) for a total of $2.01 million.
- Other agency expenditures
    - The other state agencies that the DS report considers are the Virginia Dept. Of Taxation (VDT), the Virginia General Assembly's Coal and Energy Commission (VCEC), and the Virginia Dept. of Forestry (VDF).
    - The DS report estimates that the share of VDT's budgeted expenditures related to the coal industry are proportional to the amount of value produced by the coal industry relative to the non-governmental Gross State Product (GSP), equaling $280,000.
    - The VCEC advises the Virginia General Assembly on coal and energy issues. The DS report estimates that costs related to the coal industry are $10,000.
    - VDF's spending on coal is negligible – they provide seedlings for mining land rehabilitation.
- Academic institutions
    - Because of a lack of information, the DS report does not estimate the Virginia state government's net GF expenditures on coal-related educational programs at commonwealth universities.

- Virginia Dept. of Transportation
  - The DS methodology attempts to indirectly measure the roadway costs associated with coal-hauling traffic using Virginia Dept. of Transportation (VDOT) data, but their methodology is problematic and their final estimate is unlikely to represent the true fiscal impact related to the transportation of coal (see Chapter 5 of this report for our analysis of roadway damage and the corresponding costs due to coal-hauling trucks).
  - The DS report estimates the commonwealth's expenditure due to the coal industry transportation operations to be $1.5 million.

C. State Government Expenditures (off-budget)

  - The DS report follows the definition of the Virginia Dept. of Taxation (VDT) definition of tax expenditures, which equates tax expenditures to direct on-budget expenditures.
  - Per VDT (2009b), tax expenditures are "provisions in the tax code, such as exclusions, exemptions, preferential tax rates, deductions, deferrals or credits that are designed to provide an economic incentive for a certain activity or provide financial assistance in the form of tax relief to taxpayers in economic situations."
  - Per VDT (2009b), "The tax expenditure concept recognizes that the fiscal impact of a tax provision is similar to the outlay of a direct [on-budget] expenditure. One of the major differences between a tax expenditure and a direct expenditure is that the 'cost' is measured by reduced tax collections,

instead of by the level of the expenditure authorized through the normal legislation appropriation process."

  - DS applies this definition broadly, accounting for both coal industry-specific tax expenditures as well as tax expenditures available to *every* industry.

- Summary: The DS report estimates that coal industry-specific tax expenditures totaled $32.2 million in FY2009 while more general tax expenditures (those available to more or all industries) received by the coal industry totaled $5.23 million.
- Tax expenditures from the corporate income tax
  - Coalfield Employment Enhancement Tax Credit
    - This is an implicit subsidy for coal production which begins as a tax exemption but if the exemption is larger than the tax responsibility, it becomes an explicit subsidy for coal production. DS estimated the base value of the tax credit in FY2009 to be $25.7 million and the amount attributable to the coal industry to be $22.2 million.
    - The DS's analysis of this coal industry-specific tax expenditure seems reasonably accurate.
  - Coal Employment and Production Incentive Tax Credit
    - This is a similar subsidy to the Coalfield Employment Enhancement Tax Credit but is instead applied to in-state use of coal produced in Virginia. The mechanisms of the law essentially allow for the full potential value of the credit to be realized, which the DS report estimated at $10.0 million in FY2009.

        - The DS's analysis of this coal industry-specific tax expenditure seems reasonable.

- Tax expenditures from Virginia's sales and use taxes
    - Tax exemption for pollution control equipment
        - The DS methodology to calculate this energy industry-specific tax exemption calculates the ratio of annual production value of coal relative to the summed production value of coal, gas and oil and then multiplies this factor by the total value of this exemption as an estimate of the coal industry's benefit from this tax expenditure, equaling $2.24 million.
        - The DS analysis of this energy industry-specific tax expenditure is fairly general and of uncertain accuracy – no estimate is made of whether the coal industry uses this tax exemption more or less than other industries.
    - Tax exemption for industrial machinery and equipment
        - The DS methodology calculates the coal industry's share of non-governmental GSP and multiplies this factor by the total value of the tax expenditure as an estimate of the value of the tax expenditure provided to the coal industry, totaling $2.99 million.
        - The DS analysis of this non-industry-specific tax expenditure is fairly general and of uncertain accuracy – no mention is made of whether the coal industry uses this tax exemption more or less than other industries.

II. Coal Industry Direct Employment Impacts on the Virginia State Budget

A. Revenues (GF)

- Summary: The DS report estimates that the direct employment in the coal industry was responsible for $20.21 million in General Fund tax revenues in FY2009.
- Individual income taxes
    - The DS report estimates that direct employment in the coal industry in Virginia was responsible for $13.11 million in individual income tax revenues.
    - DS uses the nationally-based average wage of those employed in the coal industry, multiplied by the number of coal workers in Virginia and by the average effective state income tax rate (which is calculated as the proportion of individual income taxes paid relative to the total adjusted gross income in Virginia) to calculate this value.
- Sales and use taxes
    - The DS report estimates that Virginia collected $6.4 million from sales and use taxes due to consumption by those directly employed by the coal industry.
    - They do not use the full sales/use tax of 4% but instead use the effective tax rate (2.0%) reported by Institute on Taxation and Economic Policy (2009) for 'general sales-individuals' within the salary range of the average coal industry employee. They apply this tax rate to the previously estimated total estimated coal industry wages (which are assumed to be

the total adjusted gross income to which this tax rate would apply) to determine the total revenue.

- Other taxes
    - o The DS report estimates the other taxes they consider to be proportional to the coal industry's share of total employment. Total 'other' tax revenue is estimated to be $700,000, where 'other' refers to taxes on property transfers and wills/estate administration.

B. Revenues (TF)

- The DS report estimates the taxes and fees paid by those directly employed in the coal industry by multiplying the total funds received by the Transportation Trust Fund (TTF) and the Highway Maintenance and Operating Fund (HMOF) by the ratio of coal direct employment to total employment statewide. The final estimate is $2.94 million.
- The DS methodology is general and reflects an indirect analysis method rather than a direct method, which likely reduces its accuracy.

C. Expenditures (GF)

- DS estimates that the coal industry's share of state expenditures is the total GF expenditure, minus the on-budget coal industry-related expenditures, multiplied by the proportion of coal industry employment in the entire workforce. Their final estimate of Virginia's GF expenditures associated with persons directly employed in the coal industry is $17.1 million.
- The DS methodology is general and reflects an indirect analysis method rather than a direct method, which likely reduces its accuracy. Additionally, it counts

state expenditures targeted toward individuals as accruing to the industry they are employed by – see Appendix 1B for a discussion of this analytical perspective.

D. Expenditures (TF)

- The DS report uses the same methodology to estimate TF expenditures as it did for the TF revenues. Since the revenue and expenditure amounts DS used were the same, this resulted in a final estimation that the net impact of coal industry on the TF through direct employment is $0.

III. Coal Industry Indirect & Induced Employment Impacts on the Virginia State Budget

A. Revenues and expenditures (GF and TF)

- DS calculates the impact of indirect/induced employment related to the coal industry on the Virginia state budget in an identical fashion to the way it calculates the effect of direct employment.
- DS uses RIMS-II, economic impact computer software developed by the US Bureau of Economic Analysis, to calculate an employment impact multiplier of 3.6734 and wage impact multiplier of 2.4238 (both of which are large compared those calculated using IMPLAN) due to each coal industry job.
- The DS report estimates that coal industry indirect and induced employment results in GF revenue of $30.98 million and GF expenditures of $45.66 million, resulting in a net cost of $14.68 million.
- The TF revenue and expenditures produce a net impact of $0, similar to the direct employment methodology results.

IV. Coal Legacy Costs

A. Abandoned Mine Lands (AML's)

- The DS report states that no new AML's are being created (although new sites are still being discovered). Approximately $159 million has been spent cleaning up AML's up to the writing of the DS report. DS states that around $437 million is needed to clean up what remains.
  - Note: This is substantially in excess of the $99 million in funding needed to clean up AML's reported by VDMME in 2014 (Kesterson, 2014).
- Based on current distributions the DS report estimates that Virginia will only receive a total $125 million by 2022, when the federal severance taxes enacted by the 1977 Surface Mining Control and Reclamation Act end, although funds will continue to be disbursed until the current unappropriated balance ($2.2 billion) is fully disbursed.

B. Bond Forfeiture Sites (BFS)

- The DS report states that all but one BFS have been reclaimed and there are sufficient funds left in the account to reclaim the last site.

V. Downstream Strategies Policy Recommendations

A. "Eliminate the Coalfield Employment Enhancement and the Coal Employment and Production Incentive Tax Credits"

- Given the substantial changes in the electricity generation industry with the advent of shale gas extraction and proposed EPA regulations on carbon dioxide emissions from power plants, as well as changes in the metallurgical coal market, there may be sufficient reason to reexamine whether this legislation still accomplishes its original intent.

B. “Increase funding for the Virginia Coalfield Economic Development Authority (VCEDA) and expand the organization’s scope of work related to economic diversification”

- It is not immediately apparent what this recommendation by DS has to do with the impact of the coal industry on the state budget, though the recommendation is sensible in terms of local economic development.

C. “Create a Permanent Mineral Trust Fund”

- It is not immediately apparent what this recommendation by DS has to do with the impact of the coal industry on the state budget, though the recommendation may have merit.

D. “Ensure that funds for reclamation and water treatment of abandoned mines are sufficient for meeting all present and future needs.”

- This recommendation seems to be satisfied by planned future federal disbursements to the states from the severance taxes levied by 1977 Surface Mine Control and Reclamation Act (SMCRA).

E. “Require responsible fiscal accounting to better inform governmental budgetary decision-making”

- DS recommends that the state put into play practices and/or initiatives which provide better access to information regarding government expenditures and revenues and verify that expenditures are occurring in a way commensurate with the intention of the legislation motivating them. Such transparency seems to be a wise recommendation.

Appendix 1B – Analytical Perspective

The analytical perspective we utilize in this report rests on the 'benefits-received principle',[42] which states that in general, an individual's tax responsibility is equal to the benefits he or she receives from government expenditures. In the interest of being as transparent as possible, we provide the following set of premises that guided our determination of where to attribute each tax revenue source or government expenditure.

1) Each person or corporation is responsible for the tax revenues and governmental expenditures that their actions create or require, but are not responsible for others' tax responsibilities or revenues.
    - As an example, the coal industry is responsible for governmental regulatory efforts that ensure that coal mining externalities,[43] such as acid mine runoff, do not adversely affect other businesses or individuals.
    - Conversely, coal producers are not responsible for governmental expenditures related to firms and employees of firms with which they interact, nor do the income taxes paid by coal industry employees count as contributions to the state budget by the coal industry.
2) Firms are not responsible for providing public services for their employees through the provision of funding for government programs.

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[42]The benefits-received principle is a long-established school of thought in public economics, dating back to political theorists such as Locke and Hobbes and classical economists such as Adam Smith (Musgrave and Musgrave, 1973, p. 193).
[43]The term 'externality' in economics is used to indicate a cost of production that is not borne by the producer and therefore is not incorporated into the producer's decision-making process and whose effect is not included in the final price the consumer pays for the product. For example, coal production can produce acidic runoff into streams and rivers, which then negatively impacts the quality of the waterways and subsequently their value for fishing, boating, and other recreation, as well as lowering the value of the land adjacent to the waterway downstream from the contamination.

- For example, firms are not responsible for the current public education of children or the past public education of the adults they employ. Although businesses do benefit from the higher productivity of an educated workforce, they pay for this benefit through higher wages.
    - Although this is not a certainty, the state government stands to recover, to some extent, the cost of this education subsidy through the higher income, sales and use, and property taxes paid by the individual through his or her increased income. The state will also benefit from being more attractive to potential employers looking for a skilled workforce.

3) We draw a distinction between 'tax expenditures' (adjustments to the general tax code) which target specific industries, economic activities, or individuals/corporations ('exclusive tax expenditures') versus those tax expenditures which are available to any individual or corporation ('general tax expenditures').
    - Examples of general tax expenditures include tax exemptions and credits for charitable donations, capital investments, and education expenses.
    - Examples of exclusive tax expenditures include tax exemptions and credits for married couples, Virginia's Motion Picture Production Tax Credit, and subsidies for corporate re-location.
4) We make the assumption that on average all individuals and corporations utilize generalized tax expenditures in similar proportion to the amount of total taxes they pay. Therefore, we do not specifically account for generalized tax expenditures in our analysis, as our methodology implicitly incorporates them.

- As an example, if we estimate that the coal industry is responsible for one percent of net corporate income taxes collected by the state, we simultaneously assume that the coal industry was responsible for one percent of the total amount of general tax expenditures claimed, which is already incorporated into the net tax collection value.

5) We treat exclusive tax expenditures as specific benefits provided to the industries or individuals receiving them. In the coal industry's case, we account for them through reductions in the taxes paid by the coal industry to the Virginia state government, or if the taxes paid are exceeded and the tax credits are refundable, as direct subsidies to coal producers.
    - As an example, if the Virginia coal industry paid $10 million in corporate income taxes but an exclusive tax expenditure provided a refundable tax credit worth $12 million, then the net taxes paid would sum to -$2 million, meaning that the presence of the coal industry resulted in a cost of $2 million to the state budget (only considering corporate income taxes).
6) With the exception of our use of the 'benefits received' principle, our perspective is explicitly agnostic as to the 'proper' incidence of taxation across individuals and corporations, as this question is beyond the scope of this project.

Appendix 2 – Overview of IMPLAN

Introduction

Economic impact analysis software was used to estimate the influence of the Virginia coal industry on the rest of the state's economy. IMPLAN (IMpact analysis for PLANning), originally developed by the US Forest Service and the University of Minnesota, is an 'input-output' economic impact model and it is commonly used by governments and economic planners to estimate economic interactions between industries. In fact, IMPLAN was chosen as the economic analysis software to measure the anticipated effects of the American Reinvestment and Recovery Act (ARRA) of 2009 (USDA, 2009). Another input-output model that is commonly used, RIMS-II (Regional Input-Output Modeling System), was developed by the US Bureau of Economic Analysis (BEA).[44] The third major economic impact analysis software is produced by REMI (Regional Economic Models, Inc.).

Each input-output model uses a slightly different methodology, although they use most of the same data sources (generally this is publicly-available information compiled by the BEA). RIMS-II is the cheapest and uses the least sophisticated methodology, assuming that any local demand for goods and services is satisfied by local production before allowing local production to be exported to satisfy excess demand in other areas (EMSI, 2007). This approach ignores the existence of cross-hauling[45] and leads to an exaggeration of the multipliers[46] calculated by the

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[44]RIMS-II was used by Downstream Strategies in 'The Impact of Coal on the Virginia State Budget.'

[45]'Cross-hauling' refers to the demand for a good or service being fulfilled by a combination of local producers and imports while some local production is also shipped outside of the region for consumption elsewhere.

[46]Multipliers are a way of expressing each industry's impact on the rest of the economy. For example, the coal industry is estimated to have an output multiplier of 1.62 in Virginia in 2011. This means that, given the levels of production in every industry in Virginia in 2011 and IMPLAN's estimated interconnectedness of the industries in the state, if the Virginia coal industry produced one more dollar of output value the state economy would see a total increase of $1.62 dollars of output value. To explain this another way, $1.00 of additional coal production leads to an aggregate increase of $0.62 in production value in other industries across the state. Of course, there are strong

model (Bess and Ambargis, 2011). IMPLAN uses a 'Double-Constrained Gravity Model' to estimate Regional Purchase Coefficients (RPC's) which correspond to the percentage of each industry's local production that is used to satisfy local demand. This accounts for the existence of cross-hauling and produces smaller, more realistic, multipliers, than RIMS-II. Another, less realistic, assumption by IMPLAN is that a national production function exists for each industry. In other words, the method of production and required inputs do not vary by region, state, or county. This results in an inexact estimate of industry interrelationships at the county level and harms the accuracy of the resulting multipliers. For example, in Virginia, differing input usages of capital and labor are not adjusted due to its unique mix of underground and strip mining. The REMI model uses the Stephens technique (Stevens et al., 1983) to account for variability in industry production methods between counties, which may be superior, but there are other tradeoffs in this software including other assumptions made by REMI and it is more expensive than RIMS-II or IMPLAN (EMSI, 2007; ARKF, Inc., 2013).

The basic structure of an input-output model takes the form of a matrix with the industries in the economy listed across the columns and the rows. Each entry in the matrix represents the cash value of goods and services flowing to the column-industry from the corresponding row-industry. Table 2A-1 shows an example of this. The number listed at the intersection of the column of the electricity industry and the row of the coal mining industry ($120.35 million) represents the value of coal industry output used by the electricity industry in Virginia during 2011[47]. Similarly, the number listed at the intersection of the column of the coal

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assumptions behind these models and they should not be taken as predictions of new job creation as there are a host of offsetting effects that are not considered.

[47]The values in Figure 2A-1 are taken from the CY2011 IMPLAN analysis conducted as part of this research project.

industry and the row of the electric industry ($31.74 million) represents the value of output from the electricity industry used by the coal mining industry in Virginia during 2011.

Sample Input-Output Matrix Focusing on the Coal Mining Industry

Industry Name (IMPLAN Classification)	All coal mining and preparation (21)	Support activities for coal, mineral, and metals mining (30)	Electric power generation, transmission, and distribution (31)	Transport by rail (non-commuter, non-tourism) (333)	Transport by truck (freight) (335)
All coal mining and preparation (21)	$30.76	$0.12	$120.35	$0.00	$0.00
Support activities for coal, mineral, and metals mining (30)	$112.25	$31.24	$0.00	$0.01	$0.00
Electric power generation, transmission, and distribution (31)	$31.74	$0.91	$0.16	$0.85	$8.56
Transport by rail (non-commuter, non-tourism) (333)	$55.52	$0.50	$205.73	$8.47	$43.32
Transport by truck (freight) (335)	$26.46	$0.77	$27.80	$9.64	$166.59

Values are expressed in millions of dollars. Each column lists the value of production inputs from the the row-industry that are used by the column-industry. Likewise, each row of values lists the value of output of the row-industry that is consumed/purchased by the column-industry.

In cases where the industry is purchasing its own output (for example, $30.76 million of coal mining 'output' is used as coal mining 'input') these are likely cases where different companies within the overarching industry aggregation are purchasing services or goods from each other. In the case of the coal industry, both coal mining and coal preparation are listed under the same industry heading. It is very conceivable that some coal mining companies lack their own preparation facilities and so contract that part of production out to other companies whose output is aggregated under the 'coal mining industry' label.

Source: IMPLAN economic impact analysis (built through multipliers), Virginia (all counties and cities), 2011

Table 2A-1: Sample Input-Output Matrix

IMPLAN Methodology

IMPLAN uses a 'Social Accounting Matrix' (SAM) methodology, which extends the basic input-output method to incorporate non-market transactions and inter-institutional monetary transfers[48] (such as tax collections and unemployment benefits). Including these non-market transactions in the analysis is important in order to develop an accurate representation of the economy.

The multipliers that IMPLAN reports are actually the sum of three different effects: direct effects, indirect effects, and induced effects. Direct effects represent the change in the industry under consideration – the increase or decrease in the monetary value of production. Indirect effects represent interactions between industries. For example, when the coal industry increases production, it increases demand for the material inputs it uses in the production of coal. The other industries supplying these inputs then must increase production as well to meet this higher demand. That higher output generates its own increased demand for the relevant production inputs, stimulating a secondary indirect effect. The subsequent stages of indirect effects propagate throughout the regional economy until the indirect effect of an increase in production declines to zero. This decline occurs because each subsequent step backwards in the production chain removes some monetary value from the economic system through purchases of inputs from outside the regional economy (imports), and through taxation, profits, and savings.

The induced effect is defined as the increase (or decrease) in economic activity due to increased (decreased) household consumption stimulated by changes in the wages/salaries paid to workers in the affected industries. Production increases create a corresponding rise in the

[48]'Institutions' in this sense refer to the economic agents participating in the economy. These could be firms, households, the government, etc.

demand for labor needed in the primary industry and in the secondary industries supplying production inputs to the primary industry. The wages and salaries paid to workers in those new jobs create an increase in the aggregate household income, which in turn stimulates household demand for goods and services, such as food and entertainment. This increased household spending induces additional economic growth and job creation in the industries supplying those goods.

These effects can be represented by the relevant shifts in employment in addition to changes in output value. If the coal industry gained ten jobs then the direct effect would be 10.0. If employment in all industries supplying the inputs to the coal industry increases by six jobs, then the indirect effect of the coal industry's production increase would be 6.0. If this resulted in three additional new jobs in industry sectors supplying the goods and services demanded by households as result of the new direct and indirect jobs, then the induced effect is 3.0. In this example the gain of ten coal industry jobs resulted in nine additional jobs for a total employment growth of nineteen jobs, or 1.90 total jobs for every coal job added. This means that the coal industry would have an employment multiplier of 1.90.

It is important to realize that a full accounting of the indirect and induced effects may be larger than what is estimated by IMPLAN. This is because IMPLAN is limited by the size of the study area. Any economic effects occurring outside the study area are considered 'exports' from the study area and are not counted in the impact analysis. Figure 2A-1 shows a graphic representation of the direct, indirect, and induced effects, as well as economic transfers out of the region under consideration.

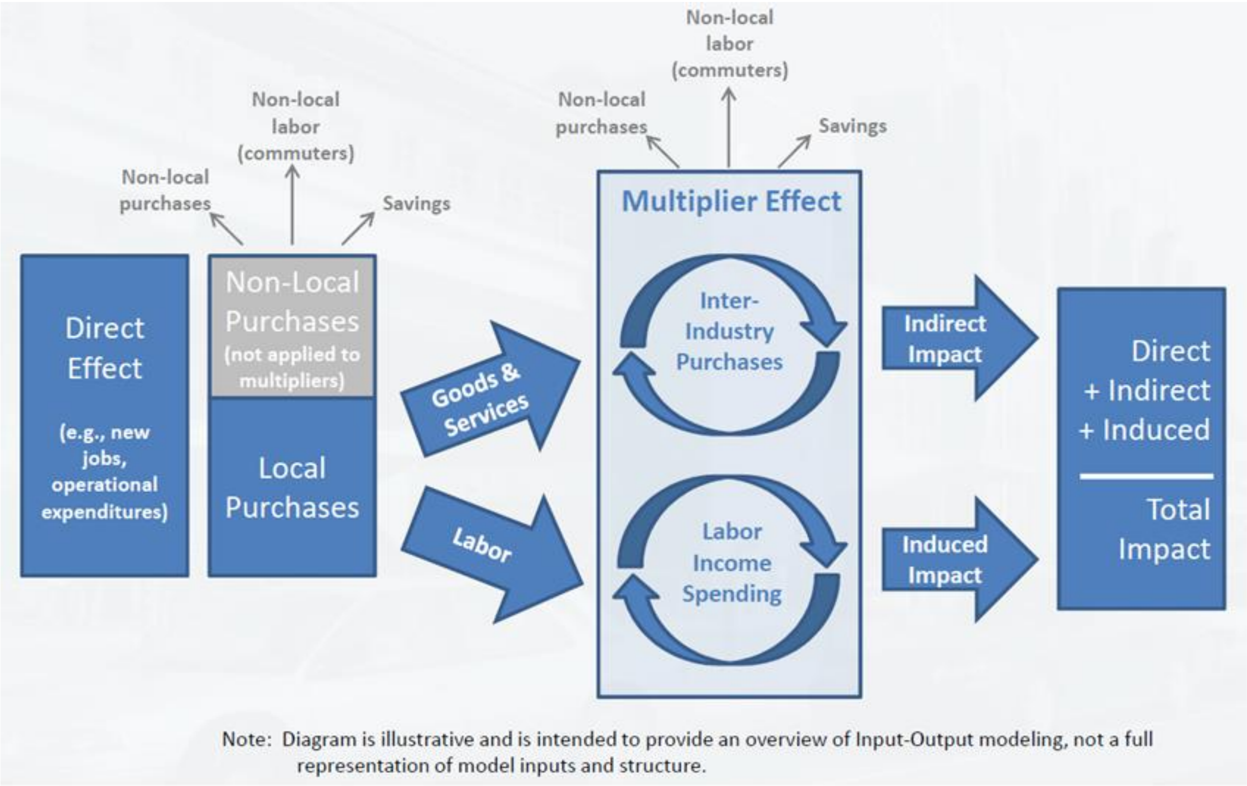

Figure 2A-1: Input-Output Modeling – Conceptual Overview

Source: (AKRF, Inc., 2013)

With regard to this report, any economic impact created by the Virginia coal industry which lies outside of Virginia (for example, manufacturing of mining machinery in other states) will not be incorporated by the IMPLAN analysis presented here. This is appropriate though, as the scope of this report is to analyze the impact of the Virginia coal industry on the Virginia state budget, not the total effect on the US economy.

Numerical Example of the IMPLAN Analysis

Suppose that the primary industry under consideration increased the value of its production by $10,000. The corresponding increase in the value of the required production inputs (goods and services) from other industries will be less than this because profits, taxes, and labor costs must also be incorporated. For example, assume that the $10,000 increase in production value includes a $500 increase in profits (and/or savings), a $1,000 increase in all taxes paid on the required inputs (sales, income, property, and labor taxes), and that the production increase necessitates a $2,500 increase in labor costs. This leaves $6,000 attributable to production inputs. Further assume that $1,500 of these production inputs are purchased from outside the state (the economic region under consideration) and that 20 percent of the labor cost is paid to commuters from outside the state. In this case, only $2,000 is paid to in-state households and the final value of payments to in-state industries for production inputs is $4,500. This is summarized in Table 2A-2.

IMPLAN Analysis: First-Stage Accounting of an Increase in Production Value	
Primary Industry Accounting:	Dollar Value:
Increase in Production Value:	$10,000 (Direct Effect)
Profits/Savings:	$500
Taxes:	$1,000
Labor (In-State):	$2,000 (Primary Industry Induced Effect)
Labor (Commuters from Out-of-State):	$500
Production Inputs from In-State Industries:	$4,500 (Primary Industry Indirect Effect)
Production Inputs Imported from Out-of-State Industries:	$1,500

Table 2A-2: First Stage of Sample IMPLAN Analysis

The remaining $4,500 of production inputs paid to in-state industries goes through the same evaluation process. Assume that $250 of this amount goes to profits/savings, $500 to taxes, $750 to labor costs and $3,000 to production inputs, of which $2,500 is paid to in-state industries, which creates a secondary indirect effect. This secondary indirect effect represents the costs of the secondary inputs required to produce the primary inputs necessary for the initial increase in production. The accounting of this process is seen in Table 2A-3.

IMPLAN Analysis: Second-Stage Accounting of an Increase in Production Value	
Secondary Industries Accounting:	Dollar Value:
Increase in Production Value:	$4,500 (Indirect Effect)
Profits/Savings:	$250
Taxes:	$500
Labor (In-State):	$500 (Secondary Industry Induced Effect)
Labor (Commuters from Out-of-State):	$250
Production Inputs from In-State Industries:	$2,500 (Secondary Industry Indirect Effect)
Production Inputs Imported from Out-of-State Industries:	$500

Table 2A-3: Second Stage of Sample IMPLAN Analysis

This secondary indirect effect then creates a subsequent tertiary indirect effect, which corresponds to the value of inputs needed to produce the secondary inputs (see Table 2A-4). This process continues until the economic impact of the increase in production by the primary industry is accounted for in each other industry in the state or else is attributed to imports/commuters, taxes, or profits/savings.

IMPLAN Analysis: Third-Stage Accounting of an Increase in Production Value	
Tertiary Industries Accounting:	Dollar Value:
Increase in Production Value:	$2,500 (Secondary Indirect Effect)
Profits/Savings:	$200
Taxes:	$300
Labor (In-State):	$400 (Tertiary Industry Induced Effect)
Labor (Commuters from Out-of-State):	$100
Production Inputs from In-State Industries:	$1,000 (Tertiary Industry Indirect Effect)
Production Inputs Imported from Out-of-State Industries:	$500

Table 2A-4: Third Stage of Sample IMPLAN Analysis

The sum of the indirect effects corresponds to the level of economic activity created by the change in the primary industry. The sum of the indirect effects across the first three stages of the analysis shown here is $4,500+2,500+1,000= $8,000. It is important to note that this value is simply a measure of resulting economic activity and is different than the value of wealth created through these economic exchanges. Wealth creation would more appropriately be measured as the sum of the profits/savings (and potentially the taxes collected as well, depending on how the tax revenues were spent).

The sum of the increased labor payments in each in-state industry is equivalent to the rise in aggregate household income. This corresponds in turn to a growth in household demand for goods and services. The increased value of this demand is defined as the induced effect. The sum of the induced effects across the first three stages of the analysis shown here is $2,000+$500+$400=$2,900.

If the analysis were stopped after the third stage, the output multiplier for the primary industry would be 2.09 - for every $1 in production increase in the primary industry it leads to a total $2.09 increase in economic activity in the region. This is calculated by summing the direct, indirect, and induced effects and dividing the result by the direct effect ($20,900/$10,000 = 2.09). The indirect and induced contributions are 0.80 and 0.29 respectively, indicating that the growth of the primary industry impacts other industries more than it does households.

Criticisms of the IMPLAN Methodology

It is important to understand that the measurements of economic impacts obtained using IMPLAN (or any of the other input-output models available) are only estimations of the actual economic relationships between industries in a specific region over a specific period of time. They are not scientifically determined, as in a chemistry experiment, and they are influenced by the assumptions used to approximate the interactions between industries, households, and government. As such, the results provided by input-output models, such as multiplier values, should not be interpreted as definitive proof of each industry's impact on the regional economy. Some criticisms of the IMPLAN methodology are listed below to help explain why the values reported by an input-output analysis should not be accepted as proven facts.

1) The IMPLAN methodology uses data regarding the dollar value of industry inputs/outputs and employment during a fixed period of time. There is no guarantee that the production and consumption relationships in the given time period appropriately reflect the general trend of interactions over the long run or are robust to changes in other parts of the economy.

2) IMPLAN uses county-level data on the value of goods created and consumed by each industry/household/government and assumes that the total amount consumed will equal the total amount produced within the time period of the study. This would be correct over a long analysis period, but in the short term it ignores the potential to store supply for a future period or that current demand could be satisfied by previous production.
3) IMPLAN assumes that a portion of each county's production will be shipped to every other county which has a demand for that industry's output. The amount shipped to a distant county may be very small relative to nearby counties, but it will always be non-zero, which may not correspond to reality.
4) The IMPLAN methodology assumes that trade interactions are governed by a gravity-type model, similar to the physics equation used to calculate gravitational attraction. IMPLAN's model does not have a specific justification for the assumption that the amount of trade between two counties is proportional to the inverse-square value of the distance between them. This means that the final results are not based on a specific fundamental theory that governs trade between regions, and so should be treated as estimations rather than calculations.
5) IMPLAN does not consider price changes. So for example, in a growing economy, wages and rents are bid up, which reduces economic activity in other sectors, which potentially can be crowded out.
6) One of the most problematic aspects of the IMPLAN methodology is that it creates a national production function for each industry and assumes that this function (and corresponding industry interrelationships) applies to every county in the US (Lazarus, Platas, and Morse, 2002). Since production processes and inputs will vary spatially and

temporally based upon input costs and availability, this assumption means that the industry relationships used in the IMPLAN model should be treated as estimates of actual industry interconnections. Additionally, this production function is assumed to be linear, which means that any economic impact predictions IMPLAN generates are more likely to be accurate for marginal changes in the economy rather than large impacts (IMPLAN, 2014b).

The coal industry provides a good example of problems that can occur when a national production function is assumed. The coal produced in Virginia has a high cost per unit of production relative to coal produced in the Powder River Basin (PRB) in Wyoming because the Appalachian terrain makes accessing the coal resources more difficult. The production techniques also vary between the regions. The Virginia coal industry uses a mix of surface and underground mining methods that require a relatively high amount of human labor while the PRB can utilize a higher proportion of capital investment through the use of massive earth-hauling machinery in its enormous surface mines.

7) Another concern with the IMPLAN methodology is that it treats the output value of each industry as a product which does not vary in attribute or quality between regions or even within the industry itself (IMPLAN, 2014c). As such, quality or use differences between different goods produced by the same industry are not accounted for in the model.

The Virginia coal industry provides a good example of why this approach is problematic. The Virginia coal region produces both steam coal for electricity generation and metallurgical coal for steel production. Metallurgical coal is substantially more scarce and valuable than steam coal and it commands high prices in international markets, so it would rarely be used for electricity generation. However, the IMPLAN model does not differentiate between trade flows of metallurgical coal demanded by US and international steel producers and steam coal demanded by Virginia power plants, treating all demand and supply as the same. This means that crucial information influencing how much Virginia-produced coal will be consumed within the state is not incorporated in the IMPLAN model.

8) The results of IMPLAN, or any of the other input-output models, cannot be compared with actual trade flows to verify the accuracy of the estimated economic impacts. IMPLAN itself acknowledges the fact that there is no definitive proof that the trade flows its double-constrained gravity model predicts are correct (Lindall, Olson, and Alward, 2005).

Conclusion

Input-output models such as IMPLAN represent powerful tools to model economic interactions throughout the entire economy. They can be very useful to examine how specific industries are interrelated and to explain how a change to one industry might cause effects to ripple throughout the rest of the economy. However, the results of these models are only as correct as the assumptions that they are built on. The assumptions that IMPLAN uses to create a tractable model indicate that the final results should be interpreted only as unverifiable estimates of the actual economic impacts. However, it is possible to say that IMPLAN produces a reasonable estimate of the number of jobs "supported" by an industry, though it cannot say anything definitive about the net job creation due to the industry.

Appendix 3 - Estimation of Coal Industry-Related Expenditures by the Virginia Department of Taxation

Data

The Virginia Department of Taxation (VDT) maintains records of the tax revenues it collects and its own expenditures. The US Bureau of Economic Analysis (US BEA) collects aggregate and industry-specific data on the economic output of US states and counties, which the IMPLAN analysis conducted as part of this research uses to determine the size of industries and their economic inter-relationships.

Methodology

1) The US BEA average annual estimate of the value of production of Virginia's mineral mining industries (excluding oil and gas) from CY2009 through CY2012 is $2.60 billion[49] (US BEA, 2014). The non-coal mining industries accounted for only 24% of the total value of mining output in CY2011 according to the IMPLAN analysis. Multiplying the estimated production value for the non-oil and gas mining industry by 76% therefore provides an estimate of the average annual dollar value of goods and services produced by the coal industry ($1,976.2 million).
2) The US BEA average annual estimate of GSP for all private industry in Virginia from CY2009 through CY2012 is $337.837 billion[50] (US BEA, 2014). We divide the average annual production value estimate for the Virginia coal industry by private industry GSP to provide an estimate of the coal industry's share in Virginia's private industry GSP (0.585%).

[49]Expressed in chained 2009 dollars. Data for CY2013 is not yet available.
[50]Expressed in chained 2009 dollars. Data for CY2013 is not yet available.

3) The average corporate income tax collected by the Virginia Department of Taxation from FY2009 through FY2012 was $784.17 million (VDT, 2009; VDT, 2010a; VDT, 2011a; VDT, 2012a). The average annual state sales and use tax revenues directed to the General Fund and Transportation Trust Fund[51] from FY2009 through FY 2012 was $3.522 billion (VDT, 2009; VDT, 2010a; VDT, 2011a; VDT, 2012a). These are the two primary ways in which taxes paid by private industry would be collected by the VDT. We use the sum of these tax payments, $4.306 billion, as an estimate of the taxes paid by private industry which are collected by VDT. This amount represents 29.3% of the total taxes VDT collected - the majority of the other tax payments collected by the VDT come from individual income, estate, and specific excise taxes (VDT, 2009; VDT, 2010a; VDT, 2011a; VDT, 2012a).
4) The VDT's average annual expenditures from FY2009 through FY2012 totaled $86.2 million (VDT, 2009; VDT, 2010a; VDT, 2011a; VDT, 2012a), of which 29.3% ($25.28 million) is estimated to be the cost of collecting taxes from private industry. The coal industry's share of this tax collection cost is estimated to be 0.585%, which corresponds to the coal industry's share of private industry GSP. Therefore, the average annual cost to the VDT for collecting taxes from the coal industry is estimated to be $148,000.

Important Assumptions and Background Information

- This methodology is similar to that used by Downstream Strategies (2012).[52]

[51] Virginia has a number of sales and use taxes, with the primary such tax being the Retail Sales Tax, which is applied to all retail sales. The revenue from this tax is split between the Virginia General Assembly's General Fund, the Transportation Trust Fund, and local municipalities. We only count the portion accruing to the state government.

[52] The US BEA revised their estimation of GSP attributable to mining industries in their June 2014 data release, resulting in a significant upward revision in the mining industry's share of private industry GSP (Taylor, 2015; Kim, Strassner, and Wasshausen, 2014). For this reason, while our methodology may be similar to that of Downstream Strategies, it may return somewhat different results.

- The implicit assumption behind this analysis is that the costs associated with collecting corporate income taxes and sales and use taxes from each industry are proportional to the share of private industry Gross State Product that each industry produces. Virginia levies a flat tax of 6 percent on taxable corporate income (VDT, 2014b), so this assumption would seem to be fairly reasonable, although actual cost of collecting taxes from each industry would depend on the existence of industry-specific tax laws and other industry-specific variations.
- We assume that the IMPLAN analysis properly estimates the value of production from coal and other mining industries.
- Our methodology implicitly assumes that 100% of the state sales and use tax revenues directed to the General Fund and Transportation Trust Fund are paid by firms in the state of Virginia, rather than part of these taxes being paid by commonwealth residents through purchases of goods and services for final consumption, which would be more realistic. This simplifying assumption likely overstates the estimated cost of collecting taxes from the coal industry, but since the final estimate of VDT's expenditures related to the coal industry is relatively small compared to other direct on-budget expenditures, this assumption only marginally affects the final result.

Appendix 4A - Estimation of the Corporate Income Tax Paid by the Coal Industry

Data

The US Bureau of Economic Analysis (US BEA) collects aggregate and industry-specific data on the economic output of US states and counties. The IMPLAN analysis conducted as part of this research uses this and other data to determine the size of industries and their economic inter-relationships. Lastly, the Virginia Department of Taxation (VDT) maintains records of the corporate income taxes paid to the commonwealth.

Methodology

5) The US BEA average annual estimate of the production value of Virginia's non-oil and gas mineral mining industries from CY2009 through CY2012 is $2.60 billion[53] (US BEA, 2014). The non-coal mining industries accounted for only 24% of the total value of mining output in CY2011 according to the IMPLAN analysis. Multiplying the average annual production value for the non-oil and gas mining industry by 76% therefore provides an estimate of the value of production of the coal industry ($1,976.2 million).
6) The average annual estimate of the Virginia coal industry's production value is divided by the average annual private industry Gross State Product (GSP) from CY2009 through CY2012, which equals $337.837 billion,[54] to provide an estimate of the coal industry's share of Virginia's private industry GSP, which equals 0.585% (US BEA, 2014).
7) The average annual net corporate income tax collected in Virginia from FY 2009 through FY2012 was $784.17 million (VDT, 2009; VDT, 2010a; VDT, 2011a; VDT, 2012a). Multiplying this amount by the coal industry's estimated average annual share of private

[53]Expressed in chained 2009 dollars. Data for CY2013 is not yet available.
[54]Expressed in chained 2009 dollars. Data for CY2013 is not yet available.

industry GSP (0.585%) provides a rough estimate of the annual corporate income tax paid by the coal industry, $4.59 million.

Important Assumptions and Background Information

- This methodology is similar to that used by Downstream Strategies (2012).[55]
- The implicit assumption behind this analysis is that the amount of corporate income taxes paid by each industry is proportional to the share of private industry Gross State Product that each industry produces. Virginia levies a flat tax of 6 percent on taxable corporate income (VDT, 2014b), so this assumption would seem to be fairly reasonable, although actual taxes collected from each industry would depend on the existence of industry-specific tax laws and other industry-specific variations.
- Additionally, we assume that the IMPLAN analysis properly estimates the value of production from coal and other mining industries.

[55]The US BEA revised their estimation of GSP attributable to mining industries in their June 2014 data release, resulting in a significant upward revision in the mining industry's share of private industry GSP (Taylor, 2015; Kim, Strassner, and Wasshausen, 2014). For this reason, while our methodology may be similar to that of Downstream Strategies, it may return somewhat different results.

Appendix 4B - Estimation of the Sales Tax Revenue Attributable to the Coal Industry

Data

We use the results of the IMPLAN economic impact analysis in conjunction with data on the aggregate value of taxable sales by industry and the sales tax rate provided by the Virginia Department of Taxation to estimate the value of sales tax attributable to the coal industry.

Methodology

8) The non-coal mining industries account for only 24% of the total value of non-oil and gas mining output in CY2011 according to the IMPLAN analysis. We estimate then that 76% of the mining production value is attributable to the coal industry (IMPLAN, 2011).
9) The North American Industry Classification System (NAICS) code for non-oil and gas mining is 212. The average annual total taxable sales by NAICS code 212 from CY2009 through CY2013 was $341.27 million (VDT, 2010c; VDT, 2011b; VDT, 2012c; VDT, 2013b; VDT, 2014c).
10) Multiplying $341.27 million by the factor of 76% provides the average annual estimate of sales tax-eligible sales by the coal industry, $259.37 million.
11) Multiplying the value of sales tax eligible sales by the coal industry by the state sales tax rate of five percent (VDT, 2012d) provides an estimate of the average annual sales tax attributable to the coal industry, $12.97 million.
12) The Commonwealth of Virginia keeps four-fifths of this amount ($10.37 million) and one-fifth ($2.59 million) is provided to the local government with jurisdiction over where each sale occurred (VDT, 2012d).

Important Assumptions and Background Information

- This methodology is similar to that used by Downstream Strategies (2012).
- Additionally, we assume that the IMPLAN analysis properly estimates the value of production from coal and other mining industries.

Appendix 4C - Estimation of the Vehicle Registration Fees Paid by the Coal Industry

Data

The data for the vehicle registration fees paid by the coal industry comes from direct communications with the Virginia Department of Motor Vehicles (Davis, 2014) and documents published by the VDMV.

Methodology

1) The VDMV provided overweight permits to 957 coal hauling trucks in CY2013; 148 of these were single-unit trucks and 809 were tractor-semitrailer trucks.
2) The cost of standard registration for each tractor-semitrailer truck was $1329.50 (VDMV, 2010). The cost of registration for the single-unit trucks was assumed to be $975 (VDMV, 2010).
3) Although overweight permits cost $70 per truck for similar trucks hauling sand, gravel, or crushed stone, coal hauling trucks are exempted from the fee.
4) All coal hauling trucks were assumed to pay the $150 Virginia Road Tax (VDMV, 2010).
5) Multiplying the number of respective truck registrations by their corresponding license costs provides an estimate of the vehicle registration fees paid to Virginia by the coal industry, $1.4 million.

Important Assumptions and Background Information

- VDMV licensed 957 trucks to carry overweight coal loads in CY2013 (CY2013 was the only full year for which information was available). An overweight load is one which exceeds the standard Gross Vehicle Weight (GVW) allowed for the truck's particular axle orientation by licensing authorities.

- VDMV issues overweight hauling permits to coal trucks free of charge, but these trucks must still obtain a standard vehicle registration. VDMV sets the price of heavy truck registrations based upon their allowable GVW (VDMV, 2010). Tractor-trailers with five- and six-axle have a standard allowable GVW of 80,000 lb. (VDMV, 2013). The allowable load for single-unit trucks varies by axle count and spacing (VDMV, 2013).
- The vast majority of coal hauling tractor-semitrailer trucks are six-axle trucks (over 98 percent). We therefore assume that all tractor-semitrailer trucks have six-axles (this does not change the final estimation, since both five- and six-axle trucks have the same standard allowable GVW). The standard truck registration fee charged by VDMV for an 80,000 lb. GVW truck is $1329.50 (VDMV, 2010).
- Since over three-quarters (77 percent) of the single-unit trucks are of the four-axle variety, we similarly assume that all single-unit trucks have four-axles for simplicity. The change in the licensing revenue estimate from this assumption is marginal.
    - We subsequently assume that all four-axle single-unit trucks have an overall axle spacing of around 29 feet (as suggested in communications with VDMV), which allows for a GVW of 61,500 lb. (VDMV, 2013; Davis, 2014). The VDMV registration for a truck with a GVW of 61,500 lb. is $975 (VDMV, 2010).

Appendix 4D - Estimation of the Fuel Taxes Paid by the Coal Industry

Data

Data for the estimation of the fuel taxes paid by the Virginia coal industry comes from a variety of sources, including the US federal government and Commonwealth of Virginia, as well as academic research.

- The diesel fuel tax in the year 2011 was $0.175 per gallon (VDMV, 2014b).
- Coal hauling trucks in the seven county southwestern coal region are estimated to have traveled 2.70 million miles (single-unit trucks) and 14.86 million miles (tractor-semitrailer trucks) during CY2011 (See Appendix 5C and Tables 5-2 and 5-3).
- The fuel economy of single-unit coal hauling trucks averages 5.85 miles per gallon (mpg) and the fuel economy of tractor-semitrailer coal hauling trucks averages 4.9 mpg (US DOT, 2014; Tolliver, Lu, and Benson, 2013).

Methodology

1) Our estimate of the daily vehicle-miles traveled by trucks likely involved in coal hauling in the southwestern Virginia counties is 7,394 miles for single-unit trucks and 40,700 miles for tractor-semitrailer trucks. Multiplying these values by 365 provides an annual estimate of the vehicle-miles traveled by the two types of coal-hauling trucks (2.70 million miles and 14.86 million miles, respectively).
2) Dividing these annual vehicle-mile estimates by the assumed average fuel economy for each vehicle type (5.85 mpg for single-unit trucks and 4.9 mpg for tractor-semitrailer trucks) results in the total estimated annual fuel consumption by coal trucks, 3.49 million gallons.

3) Multiplying this estimate of annual fuel consumption by the sales tax per gallon of diesel fuel provides an estimate of the annual fuel taxes paid by the coal industry, $611,000.

Important Assumptions and Background Information

- All fuel consumed by coal hauling trucks on Virginia roadways was assumed to be purchased in the commonwealth and therefore paid Virginia's fuel sales tax.
- The fuel consumed by coal hauling trucks off of the commonwealth's roadways or in idling is assumed to be negligible.
    - This assumption is likely not fully accurate, given standard practices regarding freight and construction hauling, likely leading to an underestimation of the fuel consumed/purchased by the coal industry (and the corresponding fuel taxes payments). However, the assumption is retained in order to simplify the analysis.
- Coal hauling-type trucks are defined as single-unit trucks with four or more axles (these are generally the larger dump trucks seen on roadways) and tractor-semitrailer trucks with six or more axles (these are similar to the standard "18-wheeler" trucks commonly seen on highways, but "18-wheelers" are generally 5-axle tractor-semitrailers).[56]
    - These coal hauling-type trucks are similar to standard roadway trucks, but have an extra axle to lessen pavement damage from the load they carry. As a result, they are generally used in conjunction with overweight hauling permits to increase the load that may be transported.

[56] The "18-wheeler" moniker comes from the fact that in most cases, the double axles supporting the semitrailer at either end have dual wheels (two tires on each side of the axle) while the front axle of the tractor unit is a single-wheel axle, resulting in a total count of 18 tires touching the pavement from five weight-bearing axles. In comparison, a six-axle tractor-trailer generally has a third axle with dual wheels at the rear of the trailer unit, which allows it to carry more weight and/or damage the roadway to a lesser degree than a similar truck with less axles. The same principle applies to single-unit dump trucks with 'extra' axles.

  - Data provided by the VDMV indicates that for the year 2013, overweight hauling permits were provided to 957 trucks, of which 12 percent were four-axle single-unit trucks and 83 percent were six-axle tractor-semitrailer trucks. The remaining five percent were either three-axle single-unit trucks or five-axle tractor-semitrailer trucks. To simplify the analysis, we assume that all coal hauling trucks are either four-axle single-unit or six-axle tractor-semitrailer trucks.
- The fuel economy of four-axle single-unit trucks is assumed to be 5.85 miles per gallon of fuel. The fuel economy of six-axle tractor-semitrailer trucks is assumed to be 4.9 miles per gallon of fuel.
  - The national average fuel economy for single-unit trucks[57] from 2007-2011 was around 7.4 miles per gallon. The national average fuel economy for combination trucks[58] from 2007-2011 was around 6.0 miles per gallon. However, these values are national averages across a large variety of sub-types of trucks within each major classification.
  - However, the US DOT national averages do not do a good job accurately reflecting the actual coal transport situation in southwestern Virginia.
    - Coal hauling trucks in southwestern Virginia are generally loaded to a substantially higher weight (due to the overweight permits provided by the VDMV) than most freight- or material-hauling trucks using the national highway system. These higher weights would reduce the fuel economy of coal trucks relative to a similar truck carrying a lighter load.

[57]US DOT (2014) defines 'single-unit trucks' as "Trucks on a single frame with at least two axles and six tires."
[58]US DOT (2014) defines 'combination trucks' as "tractors with one semitrailer up to 48 feet in length or with one 28-foot semitrailer and one 28-foot trailer."

    - The national average incorporates a high proportion of more efficient highway mileage. In contrast, most over-the-road coal hauling in southwestern Virginia consists of relatively short trips on secondary road networks.[59]
    - The terrain of southwestern Virginia is known for its ruggedness, leading to a rolling and twisting roadway network that would result in higher fuel consumption from increased deceleration/acceleration and climbing maneuvers required by the terrain.
  - Instead, fuel economy estimates will be taken from Tolliver, Lu, and Benson's (2013) estimates, which incorporate the effect of higher vehicle weights.
    - They estimate that as six-axle tractor-trailer truck with a GVW of 100,000 lb. has a fuel economy of 4.9 miles per gallon. Although this is 10,000 lb. less than the maximum GVW allowed by VDMV's overweight permits for similar coal hauling trucks, we use this value for simplicity.
    - They estimate that as five-axle tractor-semitrailer truck with a GVW of 60,000 lb. has a fuel economy of 6.2 mpg and the same truck with an 80,000 GVW has a fuel economy of 5.5 mpg. Although this does not represent the four-axle single-unit coal-hauling truck permitted by the VDMV for a gross vehicle weight of up to 70,000 lb., we use the average of these listed GVW's (5.85 mpg) for lack of better information.

[59]Coal trucks hauling overweight loads are actually prohibited from using interstate highways in Virginia, although this is not a relevant consideration in the southwestern coal counties which are not currently served by interstate highways.

- Although using these lower estimates of fuel economy helps include the impact of higher coal truck hauling weights, these values are still national averages which include the effect of more efficient highway transport and do not incorporate the influence that the southwestern Virginia terrain would have on fuel economy. Our fuel consumption and corresponding fuel tax revenue estimates may therefore be underestimated.

Appendix 5A – Estimation of the Pavement Damage Attributable to Coal Hauling Trucks

Data

The data for the estimation of pavement damage attributable to coal hauling trucks comes from a variety of sources:

- VDMV provided data on the number, types, and weight allowances for coal hauling trucks (Davis, 2014; VDMV, 2013). Unloaded vehicle weights for the relevant truck types were obtained from a survey of media produced by commercial truck sellers and service firms (Grit Industries, 2014; Laura Kopetsky Tri-Ax, Inc., 2014).
- The University of Washington's Pavement Interactive project provided the equation to estimate the pavement damage caused by each kind of coal hauling truck (Pavement Interactive, 2009).

Methodology

4) VDMV data shows that two truck types (four-axle dump trucks and six-axle tractor-semitrailers) are predominantly used to haul coal (Davis, 2014). Virginia's coal hauling permit allows coal trucks to be loaded heavier than standard commercial trucks (VDMV, 2013). This means that the pavement damage caused by each truck type must be calculated rather than use standard design tables with assumed truck weights.
5) We use the Load Equivalency Factor[60] (LEF) equation (See Equation 5A-1) for asphalt pavements provided by Pavement Interactive[61] (2009) with information on the unloaded

[60]Load Equivalency Factors are used to establish a method of comparison for the pavement damage done by different trucks loaded to different weights. The value of the LEF is the number of ESAL's (Equivalent Single Axle Load) caused by the truck. An ESAL is a standardized pavement damage measurement benchmarked by an 18,000 pound load supported by a single axle (Pavement Interactive, 2007).

truck weights (Grit Industries, 2014; Laura Kopetsky Tri-Ax, Inc., 2014) and assumptions on the distribution of weights between each truck's axle groups to calculate the pavement damage for each coal truck type. See Table 5A-1 for loaded and unloaded truck weights and their corresponding LEF's.

Important Assumptions and Background Information

- We assume that the unloaded tractor and semitrailer portions of a tractor-semitrailer distribute their weight between their axles similar to a simply-supported beam, meaning that half the weight is supported by each axle group. We employ similar engineering judgment to estimate the weight distribution between axles for dump trucks where it is more likely to be unequally distributed (see Table 5A-1).
- When the semitrailer is loaded with coal, we assume that the coal hauling permit limits regarding the allowable weight per axle group are not exceeded (44,000 pounds for tandem axles and 54,500 pounds for tri-axles). For fully loaded four-axle dump trucks, we similarly assume that the rear tri-axle bears the maximum allowable weight, 50,000 pounds.
- We assume that "p_t" – the terminal serviceability index – equals 1.5 (See Equation 5A-1). This is equivalent to assuming that the full damage capacity of the pavement is consumed and that the ride quality of the pavement at the end of its functional lifetime is severely degraded. This simplifies the analysis by allowing coal hauling traffic to consume the entire damage capacity of the roadway, forestalling the need to account for the 'leftover' damage capacity. It also simplifies the calculation of the LEF equation by canceling out

[61] Pavement Interactive is an online information resource for the roadway pavement community sponsored by multiple state Departments of Transportation, the Federal Highway Administration and led by the University of Washington. Its mission is to serve as a knowledge base and reference tool for pavement topics (Pavement Interactive, 2014).

the LEF's dependency on roadway quality and leaving the LEF to depend only on the number of axles and the load they bear (see Equation 5A-2).

$$\frac{W_x}{W_{18}} = \left[\frac{L_{18}+L_{2s}}{L_x+L_{2x}}\right]^{4.79}\left[\frac{10^{G/\beta_x}}{10^{G/\beta_{18}}}\right]\left[L_{2x}\right]^{4.33}$$

Where: W = axle applications inverse of equivalency factors (where W_{18} = number of 18,000 lb (80 kN) single axle loads)

L_x = axle load being evaluated (kips)

L_{18} = 18 (standard axle load in kips)

L_2 = code for axle configuration

1 = single axle
2 = tandem axle
3 = triple axle (added in the 1986 AASHTO *Guide*)
x = axle load equivalency factor being evaluated
s = code for standard axle = 1 (single axle)

G = $\log\left(\frac{4.2-p_t}{4.2-1.5}\right)$ a function of the ratio of loss in serviceability at time, t, to the potential loss taken at a point where p_t = 1.5

p_t = "terminal" serviceability index (point at which the pavement is considered to be at the end of its useful life)

b = $0.4+\left(\frac{0.081(L_x+L_{2x})^{3.23}}{(SN+1)^{5.19}L_{2x}^{3.23}}\right)$ function which determines the relationship between serviceability and axle load applications

SN = structural number

Source: (Pavement Interactive, 2009)

Equation 5A-1: Load Equivalency Factor

$$\frac{W_x}{W_{18}} = \left[\frac{L_{18}+L_{2s}}{L_x+L_{2x}}\right]^{4.79}\left[L_{2x}\right]^{4.33}$$

Source: (Pavement Interactive, 2009)

Equation 5A-2: Load Equivalency Factor (Simplified)

Six-Axle Tractor-Semitrailer, Unloaded[1]				
	Front Single Axle	Middle Tandem Axle	Rear Tri-Axle	Total
Weight (pounds)	10,000	22,500	12,500	45,000
Load Equivalency Factor (LEF)[6]	0.07	0.17	0.003	0.24

Six-Axle Tractor-Semitrailer, Fully Loaded				
	Front Single Axle	Middle Tandem Axle[2]	Rear Tri-Axle[2]	Total
Weight (pounds)	11,500	44,000	54,500	110,000
Load Equivalency Factor (LEF)[6]	0.135	3.43	1.73	5.30

Four-Axle Dump Truck, Unloaded[3]				
	Front Single Axle	Middle Tandem Axle	Rear Tri-Axle[4]	Total
Weight (pounds)	15,000	-	10,000	25,000
Load Equivalency Factor (LEF)[6]	0.44	-	0.005	0.45

Four-Axle Dump Truck, Fully Loaded				
	Front Single Axle	Middle Tandem Axle	Rear Tri-Axle[5]	Total
Weight (pounds)	20,000	-	50,000	70,000
Load Equivalency Factor (LEF)[6]	1.62	-	1.17	2.79

Footnotes:

1 - We assume a 20,000 pound tractor weight and a 25,000 trailer weight split evenly between their supporting axles.

2 - We assume the tandem and tri-axle both support the maximum weight allowed by the coal hauling permit.

3 - We assume a 25,000 pound unloaded weight for the dump truck with the center of mass located near the engine.

4 - We assume that the four-axle dump truck retracts one axle from its tri-axle for greater maneuverability when unloaded, but this only marginally affects the calculated LEF.

5 - We assume the tri-axle both supports its maximum allowable weight allowed by the coal hauling permit.

6 - This is the flexible pavement (asphalt) Load Equivalency Factor.

Table 5A-1: Load Equivalency Factors for Coal Trucks

Appendix 5B – Pavement Design Methodology

Data

The method we employ for pavement design was initially developed by the American Association of State Highway Transportation Officials (AASHTO) in the *AASHTO Guide for Design of Pavement Structures*. We use pavement design guides built on AASHTO's resource available from the Ohio Department of Transportation (ODOT) and Pavement Interactive, a public knowledge base organized by the University of Washington. Both methods returned identical results. We also use other relevant data provided by VDOT and academic research.

- We use the pavement design parameters required by VDOT (2014d). VDOT also provides annual data on the characteristics of each county's roadway network (VDOT, 2011b).
- The ODOT Pavement Design Manual provided the procedure to estimate the damage capacity of a given thickness of asphalt pavement (ODOT, 2012).
- The University of Washington's Pavement Interactive project provided the means to estimate the pavement damage caused by each kind of coal hauling truck (see Appendix 5A) and provided a reassurance check on required pavement thickness calculated using ODOT's procedure.
- VDOT provided pavement material costs and information on standard roadway construction practices in Virginia's southwestern coal region (Hill, 2014; Sumpter, 2014).
- Freeman and Clark (2002) conducted a limited survey of roadway pavements in Virginia's southwestern coal region, providing a framework to validate our assumptions.

Methodology

6) We initially assume a pavement damage capacity of 500,000 ESAL's for secondary roads and 5,000,000 ESAL's for primary roads. These values were selected by considering each county's per-mile coal hauling pavement damage estimates from 2011 and the corresponding expected pavement lifespan if the 2011 level of damage occurred every year. The deciding criteria was that the pavement damage capacity was minimized (which would minimize gross construction costs), while requiring that the pavement have a lifespan of several years at a minimum.
    a. Note that this one-size-fits-all methodology oversimplifies the pavement design decisions for each coal hauling route – some roadways would see lower annualized costs if the assumption of pavement damage capacity was larger. The benefit to this methodology is that the results are more easily communicable than a more nuanced approach. More importantly, the resulting pavement thicknesses match the general trend of roadway thicknesses found by Freeman and Clark (2002) in their survey of coal region roads.
7) We use the ODOT *Pavement Design Manual* (2012) and Pavement Interactive's (2008) online pavement design calculator to determine the asphalt thickness that corresponds to the assumed damage capacities.
    a. Our results indicate that our assumption of 500,000 ESAL's of damage capacity for secondary roads necessitates 7-inches of asphalt pavement thicknesses while 5,000,000 ESAL's requires 9.5-inches of pavement thickness on primary roads. Since roadway roadways are generally designed in half-inch thickness increments, which often overshoots the minimum design damage capacity, we use instead the

full damage capacity of 7- and 9.5-inch thickness pavements (around 600,000 ESAL's and 6,000,000 ESAL's, respectively).

8) We multiply the required pavement volume per mile by the density of asphalt and the material cost of asphalt pavement to find a proxy for the per-mile cost of asphalt pavement construction.

    a. We do not include other standard construction costs, such as the cost of shoulder construction, in our estimate – we limit our investigation to the dollar value of pavement damage capacity that is consumed by coal hauling operations.

Important Assumptions and Background Information

- VDOT requires a 20-year design life for initial construction of undivided primary routes and high-volume secondary routes (VDOT, 2014d). The required pavement overlay design life is 10 years.[62] We allow for a shorter design life for our assumed pavement thickness due to the regional nature of this analysis – this design is not for a specific roadway but rather for a class of roadways using a number of generalizing assumptions. Choosing a pavement design thickness based on a minimum 10-year design life for the counties with the largest amount of coal hauling traffic would require cost-inefficient pavement thicknesses in counties with low coal hauling traffic volumes.
    - Our final assumed pavement thicknesses, 9.5-inches on primary roads and 7-inches on secondary roads, generally matches the findings of Freeman and Clark (2002), instilling some confidence in our methodology.

[62]An asphalt overlay is distinguished from full pavement construction in that an overlay only adds to or replaces the top layers of pavement whereas pavement reconstruction is the complete replacement of the entire pavement structure, most often by removing the existing pavement and replacing it with new materials.

- We implicitly assume that the estimated pavement thickness required to accommodate coal hauling pavement damage is only a portion of the total pavement thickness, the remainder of which is dedicated to accommodating pavement damage from other vehicles.
- We do not assume the contribution of any base or intermediate pavement layer strength in the pavement design calculation. This essentially considers the coal hauling damage to be absorbed by the top-most pavement layers, which then can be replaced more easily and with less total cost than a complete roadway reconstruction.
    - Assuming that coal hauling operations consume the damage capacity of a specific thickness of asphalt surface layers without affecting the pavement's base layers is a simplifying assumption that ignores the fact that a pavement's strength is nonlinearly dependent on its total thickness. In reality, the base pavement layers would serve to reinforce the upper asphalt layers that we assume are damaged by coal hauling. This means the estimated pavement thickness required to resist coal hauling damage could potentially be reduced, given the presence of base layers of pavement. This is a practical limitation of our methodology – more precise estimations would require elaborate assumptions and a specific empirically-based project dedicated to this research question.
- Pavement design parameters:
    - We use a reliability value of 85%, which is required by VDOT for rural undivided primary routes and high-volume secondary routes (VDOT, 2014d).
    - We use a standard deviation value of 0.49, which corresponds to VDOT's requirement for flexible pavements (VDOT, 2014d).

- We use an Initial Serviceability Index of 4.2, which is required by VDOT for rural undivided primary routes and high-volume secondary routes (VDOT, 2014d).
- Rather than using VDOT's mandated Terminal Serviceability Index of 2.8 (VDOT, 2014d) we use 1.5.
  - A Terminal Serviceability Index of 1.5 corresponds to substantial degradation of the pavement, at which point its entire damage capacity and useful value has been consumed. This simplifies the analysis by allowing coal hauling traffic to consume the entire damage capacity of the roadway, forestalling the need to account for the 'leftover' damage capacity.
- We estimate that the soil's modulus of resistance, M_R, is equal to 7200psi for the entire southwestern coal region.
  - VDOT's *2014 Pavement Design Guide for Subdivision and Secondary Roads in Virginia* lists a preliminary pavement design assumption of 6.0 for the California Bearing Ratio (CBR) of soils in the seven county coal region (VDOT, 2014a).
  - Design M_R = CBR x 1200psi (VDOT, 2014d).
- We use a structural layer coefficient of 0.44 for all pavement design calculations.
  - According to VDOT (Hill, 2014), the choice of asphalt concrete pavement mix used to resurface roadways in the seven county coal region depends on the road's expected usage. Secondary roadways more generally are constructed with SMA-19.0, while primary roads are often constructed with SMA-12.5. Both mixes are assigned a structural layer coefficient of 0.44 by VDOT (VDOT, 2014d).

- We use an asphalt density of 145 pounds per cubic foot when estimating material costs. This corresponds to academic research by Brown (1990) and to VDOT design manuals (VDOT, 2014d).
- We use the material cost of asphalt pavement provided by VDOT (Hill, 2014), $105 per ton of asphalt pavement applied, as an estimate of the cost of roadway reconstruction.
- We assume a 20-foot width for primary roadways and an 18-foot width for secondary roadways. This corresponds to the characteristics of a large majority of each type of roadway in Bristol District, which includes all seven counties in the coal region (2011b). Per VDOT:
    - Over 99% of all paved primary roadways in the Bristol District consist of asphalt concrete pavements.
    - 74% of all primary roadways are two-lane roads. 58% of these roads are 20-feet wide.
    - 69% of all secondary roadways in the Bristol District are paved.
    - 39% of secondary roadways are 18-feet wide, while another 50% are less than 18-feet wide.

Appendix 5C: Coal Hauling Pavement Damage: Transportation-Focused Methodology

Data

The data for the estimation of pavement damage due to coal hauling operations from a transportation perspective comes primarily from Virginia's governmental departments and from the estimations of coal truck pavement damage (Appendix 5A) and pavement reconstruction cost (Appendix 5B).

- VDOT provides annual estimations of vehicle traffic on interstate, primary, and secondary roadway networks for each county (VDOT, 2012b) and the characteristics of each roadway network (VDOT, 2011b).
- VDMV provided data on the number, types, and weight allowances for coal hauling trucks (Davis, 2014; VDMV, 2013).
- The SEER (Surveillance, Epidemiology, and End Results) Program at the National Cancer Institute (NCI) provides county-level population estimates (NCI SEER, 2014).

Methodology

9) We divide the Daily Vehicle Miles Traveled (DVMT) for each type of coal truck on each county's primary and secondary roadway network by the county population to create a population-weighted traffic measure (VDOT, 2012b; VDMV, 2013). See Table 5-2 and 5-3.
10) We subtract Scott County's DVMT per-capita for each truck type from that of each other coal-region county to form an estimate of the truck traffic specifically attributable to the coal industry.

11) We multiply the resulting coal truck traffic measure by each county's population to regain an estimate of DVMT that is specifically attributable to the coal industry.

12) We divide the coal industry DVMT by two and multiply it by 365 to create an estimate of the annual one-way coal truck traffic. We multiply this by the Load Equivalency Factor for each loaded coal truck to obtain an estimate of the annual pavement damage associated with coal hauling (See Tables 5-4 and 5-5).

13) The damage capacity of our assumed roadway design (see Appendix 5B) is divided by the sum of the estimated damage caused by all coal hauling operations in 2011. This provides an estimate of the expected lifetime if all the coal hauling traffic used the same road.[63] Dividing the material cost roadway construction by this pavement lifespan returns a simplified estimate of the total dollar cost of damage[64] caused by coal hauling in 2011.

14) We multiply the total dollar cost of damage by each county's proportional share of the total pavement damage caused by coal hauling activities. This produces an estimate of the actual cost of pavement damage in each county due to coal hauling traffic in 2011 (see Tables 5-4 and 5-5).

Important Assumptions and Background Information

- The core assumption regarding this portion of the analysis is that VDOT accurately estimates the actual coal hauling traffic each year. Often traffic estimates such as the one used here are based on relatively brief data collection activities and generally do not cover every route in the roadway network. The data that is collected is aggregated with data from other time periods and other locations in order to produce more complete

[63]Because of the mathematics of the pavement damage analysis, this assumption does not change the results, yet simplifies the methodology.

[64]The dollar value of pavement damage can also be thought of as the cost of the pavement material needed to replace the pavement damaged by coal hauling activities.

estimates of traffic patterns. This means that it might be possible that the VDOT data does not accurately capture coal hauling traffic fluctuations resulting from year-to-year changes in production. Similarly, if the roadways chosen for data collection either over-represent or under-represent coal hauling traffic compared to the actual proportion of each county's traffic, the corresponding coal truck traffic estimates will be misrepresented.

- We subtract the coal truck-type traffic in Scott County from truck traffic in the other coal counties to estimate the truck traffic attributable to the coal industry. Scott County is the only county in the coal region which has not produced coal for an extended period of time and therefore is likely the best counterfactual for the truck traffic that might exist in the region in the absence of the coal industry. This is necessary because similar trucks are also used for hauling other minerals, gravel, sand, and debris.
- Since the DVMT estimation provided by VDOT corresponds to the full mileage traveled by each vehicle type, we divide the coal industry's DVMT by a factor of two to account for the fact that coal hauling trucks generally make round trips between the mine and preparation plant. These round-trips consist of a loaded trip from the mine to the preparation plant followed by an unloaded trip back to the mine. Table 5A-1 illustrates that a loaded truck creates substantially more pavement damage than an unloaded truck. This means that the time between pavement reconstruction events (and therefore, the reconstruction cost of the pavement damage) is determined by the level of degradation of the lane of the roadway used to travel from the mine to the preparation plant, rather than the return lane.

- We implicitly assume that the entire roadway surface will be replaced when the roadway lane traveled by loaded coal trucks reaches its damage capacity. It might instead be possible that only a portion of the roadway would need to be replaced since the returning roadway lane would likely not be as severely damaged. In most cases however, a full-width roadway replacement is standard practice for two-lane roads.

Appendix 5D: Coal Hauling Pavement Damage: County of Origin Methodology

Data

The data for the estimation of coal county of origin-based approach to coal hauling pavement damage comes mostly from various departments and organizations within Virginia and uses the estimation of pavement damage from coal hauling trucks developed in Appendix 5A and the estimation of roadway construction costs from Appendix 5B.

- VDMV provided data on the number, types, and weight allowances for coal hauling trucks (Davis, 2014; VDMV, 2013). Unloaded vehicle weights for the relevant truck types were obtained from a survey of media produced by commercial truck sellers and service firms (Grit Industries, 2014; Laura Kopetsky Tri-Ax, Inc., 2014).
- The Virginia Center for Coal and Energy Research (VCCER) maintains the Virginia Energy Patterns and Trends (VEPT) database, which includes annual county coal production (VCCER, 2014b).

Methodology

15) We use the 2011 coal production quantities reported by VCCER and assume that 100% of the coal is shipped over public roadways (VCCER, 2014b).
16) We find the coal transport capacity for each truck type (45,000 pounds for four-axle dump trucks and 65,000 pounds for six-axle tractor-semitrailers) by subtracting the assumed weight of each unloaded truck (Grit Industries, 2014; Laura Kopetsky Tri-Ax, Inc., 2014) from the maximum allowable weight permitted for that type of truck (VDMV, 2013).

17) We define a 'representative coal hauling truck' as the coal hauling vehicle which possesses characteristics equivalent to a weighted average of the proportion of coal hauling trucks which are tractor-semitrailers and dump trucks. This vehicle has a load capacity of 62,000 pounds and an LEF of 4.92.
18) Dividing the coal production by the capacity of the representative truck provides an estimate of the number of trips necessary to move the coal from the mine to the preparation plant/railway load-out facility.
19) Multiplying the required number of trips by the estimated pavement damage for the representative truck provides a per-mile estimate of the amount of damage done by coal transport during 2011.[65]
20) Dividing the damage capacity of our assumed pavement by the per-mile damage estimate provides the expected pavement lifespan if this quantity of damage occurred each year.
21) We then divide the reconstruction cost of the roadway by its expected lifespan to produce a per-mile estimate of the dollar value of pavement damage caused by coal hauling.
22) We multiply the average coal hauling trip length by the proportion of coal truck mileage which occurs on primary roadways and by the proportion that occurs on secondary roadways. We find that for the 12.2 mile average coal hauling trip length, 9.5 miles is estimated to occur on primary roadways and 2.7 miles is estimated to occur on secondary roadways.
23) We then multiply the per-mile dollar value estimate of pavement reconstruction by the average coal hauling trip length and sum them together to find the estimated total pavement damage cost for coal hauling by county of origin (See Table 5-6).

[65]This estimate effectively assumes all coal hauling in each county occurs along a single road. Because of the mathematics of the pavement damage analysis, this assumption does not change the results, yet simplifies the methodology.

24) We use a similar procedure but replace the average coal hauling trip length with the maximum permitted coal hauling trip length (85 miles) to obtain an estimate on the upper-bound of pavement damage costs attributable to coal hauling (see Table 5-6).

Important Assumptions and Background Information

- Data on the proportion of coal production shipped from mines to preparation plants/railway loadout facilities over public roads is not available, but the small number of preparation plants licensed by US MSHA (2014) suggests that a large majority of coal is transported this way.
- Assuming that the coal is transported in each type of coal hauling truck in the same proportion that each truck type is represented in the coal hauling permit data provided by VMDV is equivalent to assuming that each mine uses the same proportion of dump trucks to tractor-semitrailers and that each permitted coal truck makes the same number of coal hauling trips over the same distance.
- Four-axle dump trucks and six-axle tractor-semitrailers only comprise a 95.3% of the total number of coal hauling-permitted trucks (11.9% and 83.4%, respectively), but we treat the remaining types of dump trucks and tractor-semitrailers as the first two types for simplicity.
- The per-mile pavement damage estimate and corresponding dollar value of pavement damage are aggregated values that essentially treat each county's coal production as if it occurred at a single large mine the entire quantity of which was then shipped along one specific road to a coal preparation plant. The actual occurrence of coal hauling pavement impacts certainly depends on the actual locations of mines, their corresonding prepartion plants/railway loadout facilities, and the characteristics of the roadways connecting them,

but because of the mathematics of the pavement damage analysis, this assumption does not change the results and only simplifies the methodology.

- We assume that the maximum permitted route distance (85 mile) for coal hauling would consist of the same percentage of primary vs. secondary roadways (78% primary, 22% secondary) as were used by coal hauling traffic in 2011.

Appendix 6 – Coalfields Expressway

In 1965, Congress passed the Appalachian Development Act, authorizing the construction of the Appalachian Development Highway System (ADHS) (ARC, 2013). The President's Appalachian Regional Commission had previously reported that economic growth in the Appalachian region was constrained by the region's lack of connectivity to the rest of the nation (ARC, 2013). The Coalfields Expressway (designated as US Route 121) is not specifically part of the ADHS, but the motivation behind its construction is much the same.

The Coalfields Expressway links three portions of the ADHS – US Route 23, US Route 460, and Interstate 77. It is intended to facilitate travel in and through Wise, Dickenson, and Buchanan Counties in Virginia and McDowell, Wyoming, and Raleigh Counties in West Virginia. Highway construction in the rugged Appalachian region is difficult and expensive. Most routes consist of two-lane roads that wind through narrow valleys with above-average accident rates (VDOT, 2013b). In 1995, the Virginia General Assembly passed the Public Private Transportation Act, which allowed VDOT and private entities to work together to make transportation projects more cost effective (VDOT, 2013b). Planning for the Coalfields Expressway began thereafter. In 2006 VDOT partnered with coal mining companies Alpha Natural Resources and Pioneer Group to use the "coal synergy" construction process to make construction of the Coalfields Expressway more feasible.

Coal synergy uses large-scale coal mining equipment to reshape the rugged terrain into a form that is conducive to roadway construction. This practice generally involves using mountaintop removal mining methods to first remove the coal underlying the ridges followed by reconstruction of the landscape to a grade suitable for highway traffic. The earth-moving equipment used by coal mining companies is substantially larger and more effective at this kind of work than that typically employed in standard highway construction, obviating the need for VDOT to expend resources reshaping the landscape. The original cost of the current alignment of the Coalfields Expressway using traditional construction methods was estimated to be $5.1 billion; using coal synergy construction practices, this figure dropped to $2.8 billion.

We assume that Virginia would choose to build the Coalfields Expressway regardless of the partnership with the coal mining companies,[66] meaning that the cost savings created by coal synergy corresponds to a value provided to the commonwealth by the coal industry, which would replace state funds otherwise used for construction.[67] Once the roadway grade has been constructed the terrain remains conducive for highway construction indefinitely, which corresponds to a one-time lump sum provided to the state. This permanent value must be recalculated as an annualized value to correspond with the rest of the analysis. That is, the implicit subsidy by the industry to the state should not *all* be realized in a single year, but spread over the life of the roadway.

We assume that without the involvement by the coal industry, Virginia would have paid for the earth-moving construction costs by issuing a bond. We assume a maturity of 100 years, which corresponds to the longest bond maturities currently available, which also will minimize the annualized value created by coal synergy. This also appropriately reflects the long-term nature over which Virginia and the residents of the coal region will benefit from the Coalfields

[66]It is uncertain whether this project would have moved forward given the very high costs and limited population served. It is for this reason that we include this section as an appendix (for the sake of completeness) rather than count the corresponding effect on the state budget in the main body of the report.
[67]We acknowledge that there may also be costs, in particular potential environmental damage and public health risks, associated with the mountaintop removal mining methods used in coal synergy. However, we assume that these same costs exist regardless of whether or not the coal is mined during the process of mountaintop removal for the road construction, which would be necessary even if standard construction practices were utilized. Essentially, we consider the two situations to be equivalent and only differ by whether the commonwealth or the mining company pays for the earth-moving construction work.

Expressway. We assume bond interest rates of 3% and 5%, which correspond to the range of recent municipal bond coupons for AA bonds and those specifically offered by Virginia municipalities (WM Financial Strategies, 2015; VDOT, 2014b; Municipal Bonds, 2015). When these factors are applied to the one-time defrayed construction cost ($2.3 billion) attributed to coal synergy, the annualized cost of the bond (i.e., the annualized value of the coal industry's contribution to the state budget) ranges from $69.5 million to $72.8 million. If we had assumed higher interest rates as in the pre-recessionary period, this subsidy estimate would have been larger.

If the Coalfields Expressway is completed as currently planned and the construction cost estimates by VDOT do not substantially change, then the use of coal synergy will provide an annual value of around $70 million to Virginia over the following century. It should be noted, however, that since some portions of the Coalfields Expressway are being built with federal funds (VDOT, 2013b), some of this potential benefit may instead accrue to the federal government (or residents outside of Virginia) rather than the commonwealth.

Appendix 7 – Virginia Coal Severance Taxes

Virginia does not impose a severance tax on coal mined in the commonwealth, but it permits counties that are part of the Virginia Coalfield Economic Development Authority (VCEDA), which comprises the seven counties in the southeastern coal region, to impose their own severance taxes (CARN, 2012).[68] Virginia code limits these severance taxes to a License Tax not exceeding 1% of gross receipts from sales by coal producers and a Coal and Gas Road Improvement Tax with the same limit (VDT, 2012b). All VCEDA counties and the City of Norton impose both of these taxes, meaning that coal producers throughout the coal region pay 2% of the gross value of the coal they produce to the municipality in which it was mined (VDT, 2012b). The 1% License Tax is placed directly in each county government's general revenue fund, while the Coal and Gas Road Improvement tax is split between that county's Coal and Gas Road Improvement Fund (0.75%) and VCEDA (0.25%) (CARN, 2012).[69] Furthermore, a portion of the Coal and Gas Road Improvement Fund may also be used for the construction or repair of water and sewer infrastructure. Therefore, the local funds put toward repairing coal hauling roads, which are assisted by matching funds put forth by the Commonwealth (see Section 3 of this report), represent a fraction of the actual coal severance taxes collected by local governments.

VCEDA provided estimates on the total amount of coal severance taxes collected across the coal region from FY2009 through FY2013 (see Table 7A-1) (Jordan, 2014). The average

[68]The content of this appendix is not contained within the main body of the report because these taxes do not accrue to the state's budget. The scope of this report is the impact of the coal industry on the budget of the Commonwealth of Virginia, not the impact on budgets at all levels of government. For completeness sake, however, it is important to briefly investigate those taxes imposed by local governments, since to some extent this funding may replace roadway and economic development expenditures by the commonwealth.

[69]Wise County uses a slightly different apportionment structure, with some funding going to the City of Norton (CARN, 2012).

annual collection during this period was $38.8 million, though this value ranged from a low of $29.6 million to a high of $52.0 million. Of the total $194.0 million collected over the five year period, approximately $24.25 million was provided to VCEDA for regional economic development purposes.[70] We assume that to the extent to which the VCEDA funds and each county's severance tax receipts replace funding that might otherwise be provided by the Virginia General Assembly, this represents the impact that local severance taxes paid by the coal industry have on the commonwealth's budget.

Coal Severance Taxes		
Fiscal Year	**Estimate of Coal Severance Taxes Collected Across Virginia's Southwestern Coal Region**	
2009	$	36,904,392
2010	$	29,583,348
2011	$	43,064,268
2012	$	52,041,720
2013	$	32,443,108

Source: Virginia Coalfield Economic Development Authority

Table 7A-1: Coal Severance Tax Receipts

[70]It should be noted that we estimate an additional $5.09 million was provided to VCEDA in FY2011 due to the Virginia tax code provisions regarding the Coalfield Employment Enhancement Tax Credit and the Virginia Coal Employment and Production Incentive Tax Credit. See Section 4 of this report for additional discussion of this topic.

Appendix 8 – State Funding for Education

Virginia is constitutionally required to set standards of quality (SOQ) for the minimum education program offered by public schools in the commonwealth and provides funding to each locality's school district to help achieve these educational standards. The level of commonwealth SOQ funding provided depends upon the ability of each county or municipality to fund the necessary school operations, which is measured by the "Composite Index of Local Ability-to-Pay" (VDE, 2013). The sources of tax funding used to calculate this index are the true value of real property and the taxable retail sales for each locality, as well as the adjusted gross income of persons living in the locality (VDE, 2013). The Downstream Strategies (2012) report attempted to incorporate how tax revenues from the coal industry influenced the amount of commonwealth SOQ funding provided to each coal producing county. However, Downstream Strategies included the amount of coal severance taxes received by each locality in their estimation, which the calculation of the composite index does not take into account (VDE, 2013; Dickey, 2014). This means that the Downstream Strategies estimate of state support of local education displaced by taxes paid by the coal industry, $6.6 million, was likely inaccurate. According to the equation used to calculate the composite index (VDE, 2013) and our communications with the Virginia Department of Education (Dickey, 2014), coal severance tax collections do not decrease the state support of local education by reducing SOQ funding.

We do not calculate the portion of state SOQ education funding that is replaced by local taxes paid by the coal industry due to a lack of available information on the property values, taxable retail sales, and personal income attributable to the coal industry or those who work in it. Since the coal industry represents a sizable portion of the economy in the coal region, it may be possible that its presence would substantially decrease the SOQ education funds otherwise provided by the commonwealth, but an accurate estimation of this value is beyond the scope of this report.

Appendix 9 – Remining Abandoned Mine Lands

The Virginia Department of Mines, Minerals, and Energy (VDMME) Division of Mined Land Reclamation (DMLR) actively encourages the contemporary coal industry to remine previously abandoned mine lands (AML) (Davis, 2010). Remining allows mining companies to access deposits of coal still remaining on AML's with modern technology or to use the land itself to support other mining operations. Following remining the land is then reclaimed to the standards required by DMLR.

Many of the AML's reclaimed through the remining process are Priority 3 features (Davis, 2010). Priority 3 features are areas where the environment has been adversely impacted by coal mining, but do not constitute significant risks to public health, safety, or property (which are classed as Priority 1 and 2 features). The Surface Mining Control and Reclamation Act of 1977 (SMCRA) was focused on providing funding to reclaim Priority 1 and 2 features, rather than environmental impacts (Davis, 2010) and as a result, Priority 3 features represent a significant impact of previous coal mining operations which might remain unaddressed if not for remining.[71] Remining is responsible for a significant amount of AML reclamation - Davis (2010) finds that around 80% of the total acreage mined and subsequently reclaimed in Virginia are remining operations. The mining companies bear all costs associated with remining the AML and Davis further states that the defrayed reclamation cost represents a value to Virginia that "dwarfs the accomplishments of DMME's AML project" which had spent around a total of $109 million as of September 2014 (Kesterson, 2014). The average annual expenditure of VDMME's AML program from 2009 through 2013 was around $6.6 million (Kesterson, 2014) and we

[71] DMLR estimated the cost to reclaim identified Priority 3 AML sites at greater than $313 million (VDMME, 2015).

conservatively estimate that remining AML's represents an additional \$6.6 million in value provided to the state by the coal industry each year. However, since this added value does not actually impact the state budget – Virginia would not likely reclaim many of the remined AML's (Davis, 2010) – we do not include this estimate in the main body of the report since it lies outside the scope of the project.